SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1911.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1911.

GENERAL PHYSICS.

1418. *Aerodynamic Instruments.* **H. Zickendraht.** (Ann. d. Physik, 35. 1. pp. 47–74, June 2, 1911.)—Describes a set of instruments based upon Langley's device of a lever in a Cardan suspension, which admits of registering two components of air pressure simultaneously. The "aerodynamic field" of a body in a current of air is mapped out by means of a "manometric probe," consisting of a kind of funnel partly closed by a stopper which leaves a ring-shaped opening communicating with a spirit-level. The shape of the opening excludes the rim action of the ordinary manometer, and the probe is given a stream-line contour. The measurements show that in a square plate impinged upon vertically by an air current there is over-pressure at all points to windward. Windward and leeward sides are separated by a plane containing the plate, and in this plane the pressure is equal throughout and equal to that of air at rest. A plate exposed to a wind velocity of 7·8 m./sec. gave a maximum of 25 scale divisions in front of the centre, two minima behind the plate at a distance equal to its width, amounting to — 15 scale divisions, and a secondary maximum some distance to leeward of 1·2 scale divisions. Each scale division represented an excess of pressure of about 0·17 mm. of water. E. E. F.

1419. *Accuracy of a Modified Atwood's Machine.* **J. P. Dalton.** (Roy. Soc. Edinburgh, Proc. 31. 3. p. 416, and 4. pp. 417–423, 1910–1911.)—The object of the present paper is to show how the usual type of Atwood machine may very readily be modified so as to give synchronous chronographical records of both time and distance at various points of the fall. At one end of the spindle of the main wheel a semi-cylindrical portion of the steel is removed and replaced by a piece of hard ebonite, the whole being turned up true. Hence at a certain point during each revolution the ebonite is in contact with both of the friction rollers on which it rests, and at that moment electrical contact is no longer possible between the two sides of the apparatus. Thus, by connecting with a chronograph, a single record is obtained of the distance fallen through during each revolution of the wheel and of the time taken to describe that distance. A second pen connected to a clock gives seconds, and a third gives the moment when motion began. With this arrangement and making the usual corrections, the value of g can be determined easily to within 0·5 per cent. A. W.

1420. *Accuracy in End-standards of Length.* **H. Stadthagen.** (Zeitschr. Vereines Deutsch. Ing. 55. pp. 1525–1529, Sept. 9, 1911.)—The reasons for the uncertainty in the use of these standards are discussed; and suggestions are submitted for the removal or mitigation of the errors. Thus, (1) Standard-gauges and works-gauges often are in considerable disagreement at the outset. (2) The latter being of steel generally change after manufacture without the error being detected by careful comparison. (3) Improper use of standard- and works-gauges sometimes takes place. The actual numerical errors, depending on the length of the gauge, are given. P. E. S.

1421. *Increased Accuracy in the Use of Bifilar Suspensions.* **A. N. Shaw.** (Phil. Mag. 22. pp. 433–447, Sept., 1911.)—The author finds that the deflection variation of a bifilar suspension during the first few minutes after being distorted can at first be represented by a curve of the type $y = \mathrm{A} + \mathrm{B}\epsilon^{-\mathrm{C}t}$, where B can be expressed in terms of A and C. The character of the motion changes later and can be represented by a formula of the type $y = a + b \log t$. At first its velocity is proportional to the distance from an asymptotic value, but later it is inversely proportional to the time. In the case of bifilar suspensions it is chiefly with the first part of the curve, *i.e.*, during the primary strain, that we have to deal when seeking a correction formula. Thus the proper choice of experimental conditions enables us to use a simple formula from which the necessary corrections for after-effects can be definitely determined. The testing of bifilar suspensions and the determination of the necessary constants can easily be carried out. A. R.

1422. *Atomic Heat, Expansion, and Compressibility of the Elements.* **E. Grüneisen.** (Deutsch. Phys. Gesell., Verh. 13. 13. pp. 491–508, July 15, 1911.)—In connection with the work of Einstein and Sutherland [Abstracts Nos. 859 (1907), 18 (1911)] on atomic proper frequencies, the author shows that thermal expansion and the change of compressibility with temperature may, at low temperatures, be referred to the proper frequency of oscillation of the atoms and its change with pressure and temperature. The expansion coefficient behaves like the atomic heat at low temperatures, but increases somewhat more rapidly at high temperatures. The limiting value of $1/\mathrm{C}_p \times dv/d\mathrm{T}$ at low temperatures gives the relative change of atomic frequency with pressure. It is about double the relative volume-change under pressure. If this relation between frequency and volume is generally valid, it follows that the force directing the atom towards the rest position (which is proportional to the square of the frequency) must vary inversely to about the twelfth power of the distance between the atoms. This implies inter-atomic forces varying as rapidly as was indicated by Mie. Furthermore, for every monatomic element the relative rise of temperature during adiabatic compression equals the relative change of frequency. E. E. F.

1423. *Influence of the Oscillatory Discharge and of Temperature on the Rapidity of Decay of Torsional Oscillations.* **E. Drago.** (Accad. Lincei, Atti, 20. pp. 100–107, Aug. 6, 1911.)—The effect of an oscillatory discharge on the torsional oscillation of an iron wire, 20 cm. long and 0·8 mm. in diam., is to increase considerably the number of oscillations. The passage of an alternating current at 50 ∿ (4 amps.) through an encircling spiral, produces a similar result, as does also, though more feebly, a continuous current. A series of experiments to determine the influence of temperature having shown that the number of oscillations is much reduced by warming, and only slowly reaches its former value, precautions were taken to render any thermal effect of the electric discharge or current negligible, the results obtained being very similar to those in the first experiments. W. H. Sl.

1424. *An Extension of Fischer-Hinnen's Method of Harmonic Analysis.* **R. Beattie.** (Electrician, 67. pp. 847–850, Sept. 8, 1911.)—In order to find the coefficient of an harmonic of the nth order by Fischer-Hinnen's method, $2n$ equidistant ordinates spaced a distance π/n apart are erected. The initial ordinate is either at a distance $\pi/2n$ from the origin or at the origin itself, according as a sine or a cosine coefficient is wanted. If S_n be the mean of the sine-spaced ordinates and C_n be the mean of the cosine-spaced ordinates we have $S_n = A_n - A_{3n} + A_{5n} - \ldots$ and $C_n = B_n + B_{3n} + B_{5n} + \ldots$. A disadvantage of this method is that it only gives the value of the harmonic sought directly when all the odd multiples of that harmonic are either absent or are negligibly small. Improved methods using $4n$ ordinates are described. The distance between them is made $\pi/2n$ and the initial ordinate is taken at a distance $\pi/4n$ from the origin. A $6n$ ordinate method is also described which gives in certain cases much the most accurate results. A. R.

1425. *Direction of Force and Acceleration.* **R. C. Tolman.** (Phil. Mag. 22. pp. 458–468, Sept., 1911.)—If force is defined as the rate of increase of momentum, the equation—

$$\mathbf{F} = d/dt\,.\,(m\,\mathbf{u}) = m\,d\,\mathbf{u}/dt + dm/dt\,.\,\mathbf{u} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

allows for a change in mass as well as for a change in velocity. This is here taken as the fundamental equation of non-Newtonian mechanics. It has been shown from the principle of relativity that the mass of a moving body is given by $m = m_0/\sqrt{(1 - u^2/c^2)} = m_0/\gamma$, say, where m_0 is the mass of the body at rest and c is the speed of light. Putting this in (1) we obtain—

$$\mathbf{F} = m_0/\gamma\,.\,d\,\mathbf{u}/dt + d/dt\,.\,(m_0/\gamma)\,.\,\mathbf{u} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2).$$

An inspection of (1) and (2) shows that the force acting on a body is equal to the sum of two vectors, one of which is in the direction of the existing velocity $\mathbf{u}$, and the other in the direction of the acceleration $d\,\mathbf{u}/dt$. Hence, in general, the *force* and the *acceleration* it produces are *not in the same direction.* Further, it is shown that the force producing acceleration in a given direction has its components, parallel and perpendicular to that direction, connected by a definite relation. An application of these principles is then made to the problem of a moving charge and serves to remove an apparent discrepancy between the predictions based on the electromagnetic theory and on the principle of relativity. E. H. B.

1426. *Flow of Water through Pipes or Passages having Divergent Boundaries.* **A. H. Gibson.** (Roy. Soc. Edinburgh, Trans. 48. 5. pp. 97–116, 1911.)—Some time ago the author published the results of a series of experiments on the flow of water through tubes having uniformly diverging boundaries, in which the loss of energy corresponding to given angles of conicity of the tubes was determined [Abstract No. 648 (1910)]. These pipes, some circular, others square or rectangular in cross-section, had the same initial and the same final areas, these being respectively the same as those of circles of 1·5 and 3·0 in. diam., the ratio of initial to final mean velocity of flow being in each case 4 : 1. The present experiments were planned with a view of extending the investigation to cover a series of values of the ratio of enlargement, and also of ascertaining whether the loss in similar pipes having identical mean velocities of flow, varies with or is independent of their dimensions. The following are the chief conclusions to be drawn from the experiments: (*a*) In a circular pipe with uniformly diverging boundaries the loss of head expressed as a percentage of $(v_1 - v_2)^2/2g$ varies somewhat with the mean diam. of the pipe, and with the ratio of final to initial area, as well as with θ, the angle between opposite sides of the pipe. An increase in the mean diam. slightly reduces the percentage loss, as does an increase in the ratio of enlargement. For values of θ between 6° and 35°, however, the differences are comparatively small, and the loss of head can be expressed by the relationship: Loss $= 0{\cdot}011\theta^{1\cdot22}(v_1 - v_2)^2/2g$ ft., where θ is in degrees. The minimum loss of head is attained with a value of θ in the neighbourhood of 5° 30′. The loss of head at a sudden enlargement of section also varies slightly with the smaller diam. *d* and with the ratio of enlargement *m*, and is given very nearly by the relationship: Loss $= (102{\cdot}5 + 0{\cdot}25m - 2{\cdot}0d)\,(v_1 - v_2)^2/200g$ ft. As θ is increased from 5° 30′ the loss rapidly increases to attain a maximum, greater in every case than 100 per cent. for a value of θ in the neighbourhood of 65°. The value of θ which makes the loss equal 100 per cent. varies from 40 to 60°, and in practice a sudden enlargement of section is more efficient in the transformation of kinetic into pressure energy than is a gradual enlargement in which θ exceeds this critical value. (*b*) By projecting the parallel portion of the pipe into the space bounded by the diverging walls, the loss is in every case increased, the difference increasing with the length of projection. (*c*) In pipes of square section the minimum loss of head is obtained with a value of θ in the neighbourhood of 6°. As θ increases the loss becomes much greater—up to 35 per cent. greater—than in the corresponding circular pipe. (*d*) By making the pipes trumpet-shaped, with curves designed so as to make $d(v^2)/dx =$ constant, the loss of head in a pipe of given length may be considerably reduced. (*e*) A still greater saving, combined with great simplicity, may be effected by a design giving a gradual uniform enlargement in section from the initial section A_1 to one having an area A_2, and a sudden enlargement from A_2 to the final section A_3. The value of θ in the taper portion of the pipe, which gives a minimum loss of head, may be obtained from formulæ given in the paper, when the length of the pipe is settled. In any cases likely to occur in practice its value may be taken as follows, without any very great variation from conditions of max. efficiency:—

Ratio of enlargement	9 : 1	4 : 1	2·25 : 1
θ (rectangular pipe)	11°	12° 30′	13° 30′
θ (circular pipe)	9°	10° 30′	11° 30′

A. W.

1427. *External Friction in Fluids.* **K. R. Koch.** (Ann. d. Physik, 35. 3. pp. 613–616, July 11, 1911.)—When a fluid flows close to fixed walls, as in a pipe, the velocity of the fluid varies with the distance from the walls in some manner depending on various factors [Abstract No. 1630 (1905)]. Now, while the internal friction depends on the nature of the fluid and has a finite value, the so-called external friction between the fluid and the walls seems to be independent of the fluid used and to have an infinite value, *i.e.*, no slipping takes place at the walls. One or two investigators have, however, found a finite value for the external friction. The author has further investigated the problem by two different methods, and both gave negative results as regards slipping. In the first method acidulated water was passed through a Pt tube, and the time of passage of a given quantity of water through the tube determined from several hundred observations. No difference in the time of passage was observed, whether the tube was positively or negatively polarised or connected to earth. The second method consisted in observing the damping of the oscillations in acidulated water of a copper plate, polarised or earth-connected. Again no appreciable difference was detected. A. W.

1428. *Kinetic Gas Theory on the Relativity Principle.* **W. H. Westphal.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 590–600, Aug. 15, 1911.)—F. Jüttner has obtained from the thermodynamical function of a gas at rest the kinetical potential for a gas in motion. The equations so obtained agreed with those derived by A. Einstein and by M. Planck from the dynamics of a purely electromagnetic system [see Abstract No. 848 (1911)]. The present author, by the dynamics of an ideal gas from the standpoint of the relativity principle and the kinetic gas theory, here derives expressions some of which agree with those of the above-named workers, while others show a deviation from them. E. H. B.

1429. *Modification of v. Sterneck's Pendulum, and New Determination of the Relative Values of Gravity at Turin and Genoa.* **C. Aimonetti.** (Accad. Sci. Torino, Atti, 46. 15. pp. 605–622, 1910–1911.)—A modification of v. Sterneck's pendulum is described, similar to that already used in Denmark and adopted by the Swiss Commission, which enables the error due to vibration of the support to which the pendulum is affixed, to be accurately calculated. By means of the apparatus, the value of *g* at Genoa is found to exceed that at Turin by 0·000088 ± 2·8 × 10 m., whence, if that at Turin is 9·80571 m., at Genoa it is 9·805798 m. [See also Abstract No. 1388 (1910).] W. H. St.

1430. *Boundary Waves and Parallactic Tides.* **O. Pettersson.** (Engineering, 92. pp. 884–885, Sept. 22, 1911. Paper read before the British Assoc. at Portsmouth.)—One of the most notable features of the eastern side of the North Sea, the Skagerack, Kattegat, and Baltic was the stratification of the water in layers of different origin, distinguishable by differences in temperature and salinity. The boundary between two layers could be located by means of floats, and the currents indicated photographically by a special water-gauge and current-measurer made by Ericson and Co., Stockholm. Records are made every half-hour for stretches of 14 days. The phenomena are ascribed to secondary effects from the ocean tides in deep water outside the shallow basins. C. P. B.

1431. *Earthquake Frequency.* **H. H. Turner.** (Engineering, 92. p. 384, Sept. 22, 1911. Paper read before the British Assoc. at Portsmouth.)—Examining the catalogue of earthquake phenomena edited by Milne, the periodogram method devised by Schuster shows that no period of from 7 to 20 years existed. This would negative the idea of any relation to the sun-spot period of 11 years. C. P. B.

1432. *Weight of a Falling Drop and the Laws of Tate.* VII. *Drop-weights of some of the Lower Esters, and the Surface Tensions and Molecular Weights Calculated from them.* **J. L. R. Morgan** and **F. W. Schwartz.** (Amer. Chem. Soc., Journ. 33. pp. 1041–1060, July, 1911.) [See Abstracts Nos. 854, 987, 988 (1911).]—The object of the present research was to test more fully the Morgan drop-weight apparatus, for the purpose of (1) applying to additional substances the new definition of normal molecular weight in the liquid state; and (2) the direct comparison of the values of surface tension, as found from drop-weight, with those from the capillary rise. The following table gives the values of the critical temperature calculated according to the modified Walden relationship $t_c = \text{constant} \times (a' + a'')/a'a''$, where a' and a'' are found from the equations $w_t = w_0(1 - a't)$ and $v_t = v_0(1 - a''t)$; and the critical temperature is obtained from the expression $w(M/d)^{2/3} = k_B(t_c - t - b)$, where w is the weight of the drop.

Liquid.	t_c (calc.).	t_c (from k_B).
Pyridine	348·0	346·9
Methyl isobutyrate	279·9	282·6
Ethyl propionate	286·7	286·8
Methyl propionate	270·7	265·5
Methyl acetate	233·7	233·5
Propyl acetate	285·5	288·3
Methyl butyrate	294·5	294·0
Ethyl acetate	256·8	255·6
Ethyl formate	250·6	225·1–228·7
Amyl formate	305·7	318·6–316·2
Propyl formate	297·0	260·6–267·1
Methyl formate	234·4	201·8–206·1

The conclusions to be drawn from the above determinations are as follows: (1) If the normal molecular weight be defined as such that the value of the critical temperature calculated according to the above expression does not vary with the temperature at which the drop-weight is determined (k_B = value of constant found with benzene, the critical temperature of which is taken as 288·5°), then methyl acetate, ethyl acetate, propyl acetate, methyl butyrate, methyl isobutyrate, methyl propionate, ethyl propionate, and amyl formate are normal in molecular weight, or are non-associated. (2) It is found that only in the case of methyl acetate does the calculated t_c agree with the observed critical temperature, the fictitious critical temperatures, t_c, being higher in all the others except ethyl, methyl, and propyl formates, where it approaches the observed value with rise of temperature. (3) Methyl, ethyl, and propyl formates show varying values of t_c with the temperature. In these cases there occurs apparently a reaction which is reversible, the nature of which, however, is unknown. It cannot be said, therefore, that these liquids are either associated or normal. (4) Surface tensions in dynes per centimetre, calculated from the drop-weight by multiplication by the ratio of the benzene constant for capillary rise to that for drop-weight, are found to agree exceedingly well with those of Ramsay and Aston. The agreement of methyl formate with the figures of Ramsay and Shields is not so good, nor that of amyl formate with those of Homfray and Guye, while the values for ethyl acetate vary considerably from those of the workers on capillary rise, although these do not agree well among themselves. A. F.

1433. *Weight of a Falling Drop and the Laws of Tate.* VIII. *Relationship existing between the Weight of the Drop, the Diameter of the Tip, and the Surface Tension of the Liquid.* **J. L. R. Morgan** and **J. Y. Cann.** (Amer. Chem. Soc., Journ. 33. pp. 1060–1071, July, 1911.) (Compare preceding Abstract.)—The authors have determined the drop-weights of carbon tetrachloride, ether, benzene, pyridine, and quinoline from tips of different diameters. It was found that with certain tips and liquids the forms of the drop varied, so that the weights could not be regarded as proportional to the diam. It was found, however, that with a tip 4·51 mm. diam. comparable results might be expected, as no bulging of the drop was observed. From the numbers obtained the authors conclude that Tate's law, that the weight of a drop falling from any tip is proportional to the diam. of the tip, holds rigidly between certain definite limits, for all the liquids examined; and that the only reason that it does not hold for all liquids on all tips is that bulging of the drop on the smaller tips, and the opposite change of profile on the larger ones, causes the drop which forms and falls to obey laws which are not general, but which hold only for related liquids, *i.e.*, for those with which the bulging or change of shape in the opposite direction, would have the same weight-increasing effect. Surface tensions in dynes, calculated from the benzene constants and the drop-weight from the tip employed, are found to agree on all tips from 4·51 to 5·50 mm., independently of the diam. of the tip, as long as the drop profile is normal and the control of the drop is perfect; carbon tetrachloride gives satisfactory results only with tips around 4·5 mm. diam. A. F.

1434. *Diurnal Variation of Wind and Atmospheric Pressure.* **J. P. van der Stok.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 48–61, June 28, 1911.)—An outline is given of a mechanical theory intended to facilitate the obtaining of pressure-gradient variations from the known observational variations of the wind. The analysis is based on the equations for cyclonic motion derived by Oberbeck, and the derived quantities for several stations are tabulated to illustrate how widely the mono-diurnal variation differs, as to amplitude and phase, in the different seasons, and how it shows great divergences for places so near to each other as de Bilt, Helder, and Vlissingen. On the other hand the semi-diurnal variation shows a remarkable uniformity, the amplitude regularly decreasing from about 1 mm. near the equator to the pole. A further examination is made of the relation between friction and the resulting deviation. C. P. B.

1435. *Motion of the Earth's Pole during* 1907. **H. J. Zwiers.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 211–221, Aug. 28, 1911.)—An investigation into the motion of the earth's pole from 1890 shows that up to 1907 the variation may be closely represented by a yearly ellipse and an approximately 14-monthly circle, the motion in both curves being from West to East. In 1907 it appears that a decided change in the amount of the 14-monthly component took place, its value being increased from 0·12″ to 0·25,″ without any appreciable alteration of phase. C. P. B.

1436. *Rotation of the Sun.* **J. Storey** and **R. Wilson.** (Roy. Astronom. Soc., M.N. 71. pp. 674–686, June, 1911.)—During the period 1901–1907 Halm had made a series of visual observations on the solar rotation at the Royal Observatory, Edinburgh, from which he concluded that there was evidence of a periodic variation. The present paper describes a series of photographic determinations made with specially designed apparatus. An image of the sun, 4·2 in. in diam. was thrown on the slit plate of a powerful grating spectrograph, the third-order spectrum being used, giving a scale of 1·30 mm. = 1Å. A specially designed screen was used in front of the slit plate to ensure the selection of two diametrically opposite points of the sun's image. Twenty lines were employed, nine of them being solar, and eleven telluric. The results from the plates taken during the period 1908, Nov. 30, to 1910, March 17, are tabulated for every 5° of latitude from 0° to 75°. Notable systematic differences from the results of Adams, Halm, and Dunér are discussed, but there is found to be no certain evidence of periodic variation in the rotation velocities. C. P. B.

1437. *Ionisation of Solar Gases.* **H. Deslandres.** (Comptes Rendus, 153. pp. 10–16, July 3, 1911.)—Following up the suggestion that the phenomena of the solar atmosphere may to a great extent be explained on the assumption that they are ionised and subject to a feeble magnetic field, the effects of such forces are considered so far as they affect the velocities of the particles constituting the lower and intermediate regions of the atmosphere. Taking the idea that the negative ions are dissipated, leaving the lower solar surroundings with a negative charge, the possibility of a triple stratification is discussed, viz., a lower positive region, an intermediate one negative with the ions ascending, and a higher layer also negative, but having in general a velocity of descent. These three regions may also be identical with the regions corresponding to the well-known subdivisions of the calcium lines K_1, K_2, K_3 which are of such importance in the monochromatic registration of the solar surface by means of the spectroheliograph. If this supposition should be confirmed, many of the phenomena presented by the spectroheliograph pictures will be satisfactorily explained. Other causes of ionisation considered are the action of ultra-violet light, radio-activity, and high-temperature radiation, and the possibility of the reactive force of the magnetic field producing rotation about an axis parallel to the field being a prime feature of celestial rotations is discussed. C. P. B.

1438. *Movements of Solar Prominences.* **H. Deslandres.** (Comptes Rendus, 153. pp. 221–225, July 24, 1911.)—As noted in previous papers [see preceding Abstract and No. 1097 (1911)] there appears to be evidence of the existence of strong ionisation and a magnetic field in the region of the upper solar atmosphere. The composition of most high prominences is found to include the gases hydrogen and He, and also Ca. If the rotation and deviation of the prominence matter is really due to the magnetic field acting on the ionised particles of these gases, the effect should vary with the atomic weight of the substance. Visual observations and photographic records of prominence changes give evidence also that the phenomena may be the result of magnetic rotative action. Systematic registration of the radial motions of prominences is suggested as an important research which would give valuable data for the more detailed theoretical discussion on the above lines. C. P. B.

1439. *Molecular Velocities in Solar Spectroscopy.* **A. Perot.** (Comptes Rendus, 153. pp. 36–38, July 3, 1911.)—The precise determinations of wave-lengths of the dark absorption lines in the solar spectrum are dependent on our knowledge of the movements of the particular region of the solar atmosphere giving rise to the spectrum. The problem may also be affected by the actual velocities of the gaseous particles dependent on the state of the medium, as has been shown by numerous experiments with the mercury arc *in vacuo*. If the vapours are also centres of electric charge electromagnetic rotation phenomena will have to be considered. C. P. B.

1440. *Planetary Influence on Sun-spot Formation.* **A. Schuster.** (Roy. Soc., Proc. Ser. A. 85. pp. 309–323, July 5, 1911.)—The paper analyses the correlation between the positions of sun-spots at their first appearance and the heliocentric longitude of the principal planets, using the Greenwich data extending back to 1874. As any planetary influence would probably depend on the distance, mass, and size, the inquiry has been primarily limited to Jupiter, Venus, and Mercury. The solar surface was divided for convenience into twelve zones by meridians, and the number of spots originating in each zone carefully noted. Curves are plotted showing the variations of these numbers in each zone with the corresponding heliocentric longitudes of the planets, and a certain degree of similarity can be detected in the resulting curves for Mercury, Venus, and Jupiter, suggesting some planetary action. On further inquiry, however, it is seen that numerous minor difficulties enter into the discussion, and the reality of the variations can only be determined by further evidence. C. P. B.

1441. *Sun-spot Phenomena.* **K. Birkeland.** (Comptes Rendus, 153. pp. 456–459, Aug. 21, 1911.)—Continuing his experimental investigation of the kathode discharge from a magnetised globe, the author finds a class of disruptive discharges, which to some extent resemble the phenomena of sun-spots. The position of these discharges varies with the degree of magetisation and energy of discharge, and the similarity to spot phenomena at maximum and minimum is pointed out. C. P. B.

1442. *Electric Constitution of Sun.* **K. Birkeland.** (Comptes Rendus, 153. pp. 513–516, Sept. 4, 1911.)—To explain the retardation of magnetic perturbations with respect to the passage of spots over the sun's central meridian the author assumes the sun to be magnetised oppositely to the earth, with a magnetic moment of 10^{28} c.g.s. The granular surface of the sun is supposed to be due to a multitude of small electric arcs, with the pores as positive poles, and the intervening spaces the negative poles. The kathode rays emitted would then be regarded as the cause of terrestrial magnetic storms. C. P. B.

1443. *Rotation of Filaments in Solar Atmosphere.* **H. Deslandres** and **L. d'Azambuja.** (Comptes Rendus, 153. pp. 442–451, Aug. 21, 1911.)—The characteristic dark elongated filaments of the upper layers of the solar atmosphere have been observed systematically to determine the relation of their rotation velocities to those of the other solar regions. Previous measurements from only a few filaments, by Fox (14·18°) and Evershed (15·57°), gave discordant values, and it is evidently necessary to discuss the observations made during as extended a period as possible. Part of the discrepancy may be due to insufficient dispersion in the optical train of the spectroheliograph employed, making it impossible to isolate the central radiation K_3 from the adjoining K_2 radiation on either side. With the Meudon spectroheliograph there is provision for employing very great dispersion for these K_3 images, and the resulting spectroheliograms are extremely distinct. From the filaments found on them measurements have been made on distinctive features, as shown on the pictures on successive days, the differences giving values for the rotation velocity of the filament. The results given in tabular form show the great variety of velocities exhibited, both with respect to latitude and in different filaments at the same latitude. C. P. B.

1444. *Drawings from Photographs of Mars.* **E. M. Antoniadi.** (Roy. Astronom. Soc., M.N. 71. pp. 714–716, June, 1911.)—The drawings are made from several photographs of Mars made by Barnard in 1909 with the 40-in. Yerkes refractor, and by Hale with the 60-in. reflector at Mount Wilson. Many of the details thus recorded for the first time photographically had been seen by the author with the large refractor at Meudon, near Paris. The new photographs have been obtained with the aid of colour screens, and by this means it is now proved that the limb of the planet is not brighter than the central region. Also the general continental regions are seen to be varied in shading, and not uniformly yellow expanses as has been sometimes represented. Some of the markings appear to be identical with those portrayed as far back as 1877, thus indicating remarkable stability for certain of the natural surface features. C. P. B.

1445. *Constitution of Saturn's Rings.* **K. Birkeland.** (Comptes Rendus, 153. pp. 375–377, Aug. 7, 1911.)—During certain experiments on the production of electric phenomena resembling the zodiacal light it was found that under some conditions the discharge surrounding a magnetised steel globe took the form of a luminous ring, so much resembling the ring system of Saturn that this mode of formation was at once suggested. It is possible by proper adjustment of the current and degree of vacuum to show different structures in the luminous ring, resembling closely such features as the Crape ring and the Cassini division. Photographs of the discharge are reproduced, showing the close resemblance to the Saturnian system. C. P. B.

1446. *Repulsion of Gaseous Particles in Halley's Comet.* **P. Lowell.** (Amer. Philosoph. Soc., Proc. 1. No. 199. Chem. News, 104. pp. 85–86, Aug. 25, 1911.)—Spectroscopic records of the tail particles of Halley's Comet photographed at the Flagstaff Observatory, Arizona, are held to show that the gaseous molecules are being repelled from the sun, probably by the pressure of light. This has hitherto been regarded as impossible on account of the minute dimensions of the molecules. That the tail of a comet is due to some repelling force is evident from its position in space, always directed away from the sun along the radius vector. Two photographs were selected, taken the same evening, and the distances of various recognisable features from the nucleus measured on each. It was found that points further removed from the nucleus showed greater velocities of recession than points nearer to the head of the comet; the extreme velocities being 29·7 and 18·6 miles per second. C. P. B.

1447. *Comet Quénisset.* **F. Quénisset and F. Baldet.** (Comptes Rendus, 153. pp. 589–590, Sept. 25, 1911.)—This comet was discovered at Invissy, near Paris, on Sept. 23, 1911, presenting a diffuse round nebulosity with a central nucleus. A short tail (1°) was seen on photographs taken on Sept. 23 and 24, in position angle 322°. C. P. B.

1448. *Comet Kiess (1911b): Structure and Spectrum.* **J. P. Lagrula and H. Chrétien.** (Comptes Rendus, 153. pp. 878–880, Aug. 7, 1911.)—Three photographs were obtained during July. On July 24 it had a fine thin tail, 1° long, almost straight, in the positive angle 272°. On the 27th no trace of tail was visible on the photograph taken. The nucleus was sharp and spherical on all plates; visually it was better defined on July 28 than on the other nights. All the three spectra obtained are similar. The most intense band was the cyanogen band, and many bands of hydrocarbons were also conspicuous. The following limiting wave-lengths of the spectrum bands are given: (384, 387); (400, 402); (405, 411, 414); (420, 422); (425, 430, 438, 444); (450). C. P. B.

1449. *Spectrum of Comet Kiess* (1911*b*). **A. de la Baume Pluvinel** and **F. Baldet.** (Comptes Rendus, 153. pp. 459–462, Aug. 21, 1911.)—During the latter half of July, 1911, the Kiess Comet was bright enough for its spectrum to be photographed with a prismatic camera spectrograph, using exposures of about 60 minutes. The spectrum of *a* Lyræ (Vega) was used as comparison. The spectrum was peculiar in that little continuous spectrum was shown, and the characteristic tail bands were not shown enveloping the nucleus, but only at some distance where the tail proper commenced. The spectrum of the head consisted of two main bands, 4737 and 3882, with others at 5635 and 5165, and numerous fainter and intermediate ones. A table is given showing all the bands measured on the best plates. C. P. B.

1450. *Systematic Motions of the Stars.* **J. Halm.** (Roy. Astronom. Soc., M.N. 71. pp. 610–639, June, 1911.)—Various anomalies have been pointed out in the discussions of the radial velocities of Orion stars [Abstract No. 1581 (1910)]. On the publication of Boss's Provisional General Catalogue it was considered advisable to investigate the relationships of the star-groups as shown by their transversal movements, shown from the proper motion values. It was evident from this discussion that the particular features which distinguish the Orion stars from the others are shared by a much larger number of stars than had so far been assumed. Eddington has shown that the Orion stars form a drift moving in the direction of the solar antapex, and further, that after eliminating the Orion stars, the numbers still show distinct tendencies to accumulate in the same direction. Evidence is then given for regarding these special Orion stars as a third drifting system, and a lengthy analysis of the existing data for the relationship between the physical constants of the main stellar groups. It is concluded that there is a strong chain of empirical evidence supporting the view that the principle of equi-partition of energy is applicable to the systems of bodies constituting the visible universe. C. P. B.

1451. *Double Star Systems.* **R. G. Aitken.** (Astronom. Nachr. No. 4505. Nature, 87. p. 56, July 13, 1911. Abstract.)—A scheme of arbitrary limiting distances between the components of a double star system is proposed, in order to introduce some distinction between aggregations of stars and those actually related. These limiting distances increase rapidly with the magnitude, *e.g.*, if the combined magnitudes of a pair of stars is greater than 11·0, a distance of 1″ or less will decide the system being recorded as a double. If the combined magnitude is 2·0, then the components may be as far apart as 40″ and yet constitute a double star. C. P. B.

1452. *Peculiar Stellar Spectra.* **V. M. Slipher.** (Lowell Observatory, Bull. No. 51. Nature, 87. p. 128, July 27, 1911. Abstract.)—Several stars of the Orion type of spectrum exhibit peculiarities in the intensity of the "K" line of calcium at λ3933. Thus in β, σ, δ, π Scorpii this K line is sharp and distinct, whereas in many other stars of the same type the lines of other elements are broad and diffuse. This suggests that the calcium absorption is independent of the star. C. P. B.

1453. *Stellar Distribution and Movements.* **A. S. Eddington.** (Engineering, 92. p. 381; Discussion, pp. 381–383, Sept. 22, 1911. Paper read before the British Assoc. at Portsmouth. Observatory, No. 440. pp. 355–359, Oct., 1911. Abstract.)—Recent investigation has suggested that the stellar universe is of somewhat lenticular form, with the Milky Way in the direction of the perimeter of the formation. The peculiar subdivision of stellar motions into two main groups by Kapteyn in 1905 made it appear that a relation existed between stellar distribution and stellar movements. We have now evidence that star streaming exists in radial motions as well as proper motions. This has been found by spectroscopic methods by Halm and Campbell. Moreover, stars of later spectral type had larger motions than those of early type. C. P. B.

1454. *Form of the Gegenschein.* **F. Baldet and F. Quénisset.** (Comptes Rendus, 153. pp. 621–622, Oct. 2, 1911.)—On Sept. 25, 1911, the Gegenschein had the form of an oval patch of feeble light about 15° by 20°, the long axis being approximately along the ecliptic. Its brightness was about the same as that of the patches of Milky Way in the constellations Delphinus and Sagitta. C. P. B.

REFERENCES.

1455. *Regulator for Chronometers.* **J. Andrade.** (Comptes Rendus, 153. pp. 496–497, Aug. 28, 1911.)—Taking Caspari's analysis of the equations of motion for a deformed cylindrical spiral, it is shown that the two desiderata of sinusoidal vibration and isochronism may be attained by using two spirals connected in such a way that their joint effect produces the required regulation. C. P. B.

1456. *Effects of Errors in Surveying.* **H. Briggs.** (Roy. Soc. Edinburgh, Proc. 47. 28. pp. 349–377, 1911.)—Deals in turn with the various errors in linear and angular measurements.

1457. *Distribution of Slide in a Right six-face Subject to Pure Shear.* **E. N. da C. Andrade.** (Roy. Soc., Proc. Ser. A. 85. pp. 448–461, Aug. 15, 1911.)—The right six-face was cast out of gelatine-glycerine jelly and the slide measured by the optical method employed by K. Pearson and Pollard in their work on stresses in dams. L. H. W.

1458. *Resistance of Air.* **C. del Lungo.** (N. Cimento, 1. Ser. 6. pp. 309–319, May, 1911.)—An investigation of the sustaining force due to the horizontal motion of a horizontal plane through the air. E. E. F.

1459. *Gyrostatical Balancing of a Car.* **H. Kudo.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 79–102, May, 1911.)—A mathematical discussion of the balancing of a mono-rail car by a gyrostat, with special reference to the damping of vibrations which occur. The paper has figures in the text, numerical examples at the close, and two large plates giving graphs of the oscillations with damping and without. [See Abstract No. 1767B (1904).] E. H. B.

1460. *Limits of the Relativity Principle.* **E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 13. 16. pp. 665–669, Aug. 30, 1911.)—A general discussion of the limits to the applications of the relativity principle, it being specially pointed out that it succeeds better in translatory motions than in those of rotation. E. H. B.

1461. *Radiation in Moving Systems.* **W. H. Westphal.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 607–611, Aug. 15, 1911.)—Treats the dynamics of a massless hollow space with perfectly reflecting and non-conducting walls, filled with black radiation and having a motion of translation, the work being based upon the relativity principle. An investigation without this principle was previously given by K. v. Mosengeil. [See Abstracts Nos. 1146 (1907) and 1428 (1911).] E. H. B.

1462. *The Ben Nevis Observations,* 1898–1904. **A. Buchan** and **R. T. Omond** [with **R. C. Mossman**]. (Roy. Soc. Edinburgh, Trans. 44. pp. 1–714, 1910.)—In an appendix are discussed: The Meteorology of Glen Nevis; Mean Daily Temperatures at Ben Nevis and Fort William Observatories; Large Differences of Temperature between Ben Nevis and Fort William; Diurnal Range of Wind Direction on Ben Nevis.

1463. *Brightness of Tail of Halley's Comet.* **K. Schwarzschild** and **E. Kron.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 3. pp. 197–208, 1911.) —An analysis is given of the photometric determinations of the brightness of the comet's tail on photographs taken with short-focus cameras in Teneriffe during the spring of 1910. C. P. B.

1464. *Albedo of Clouds and Earth.* **K. Stuchtey** and **A. Wegener.** (Gesell. Wiss. Göttingen, Nachr., Math. Phys. Klasse, 3. pp. 209–235, 1911.)—Comparison measurements of the albedo of clouds and the earth made with a Martens polarisation photometer during balloon ascents at various altitudes. C. P. B.

1465. *Stellar Parallax.* **F. Schlesinger.** (Astrophys. Journ. 34. pp. 26–36, July, 1911.)—This paper is in continuation of former contributions [Abstracts Nos. 456, 748 (1911)], and gives a summary of the work in hand and discussion of the results. Special attention is drawn to the detection of guiding error, and to the use of the rotating disc for reducing the apparent star diameters. C. P. B.

1466. *Galactic Distribution of Gaseous Nebulæ and Star Clusters.* **A. R. Hinks.** (Roy. Astronom. Soc., M.N. 71. pp. 693–701, June, 1911.)—In a previous paper [Abstract No. 1104 (1911)] a discussion was given of the distribution of spiral nebulæ with respect to the Milky Way. The present paper extends the inquiry to the gaseous nebulæ and star clusters. C. P. B.

LIGHT.

1467. *Acuteness-of-vision Photometer.* **H. Malosse.** (Comptes Rendus, 152. pp. 1748–1749, June 19, 1911.)—The photometer employs two wedges of neutral glass, by the manipulation of which the illumination from the source of light tested can be dimmed until some fine type just fails to be distinguished. The method can also be applied by observing the point at which distant lights, seen through the tinted glass, disappear. But in this case the results are less accurate. J. S. D.

1468. *Effect of Gravitation on Light.* **A. Einstein.** (Ann. d. Physik, 35. 5. pp. 898–908, Sept. 1, 1911.)—Treating a variable gravitational field by the relativity theory, the author finds as a natural consequence that light passing through such a region would show a slight difference of speeds in its various parts, and might accordingly suffer a bending or refraction. Thus a beam of light passing the sun might experience a deflection of the value $4 \times 10^{-6} = 0{\cdot}83''$. By this amount the angular distance of the stars from the sun's centre would be increased. By the planet Jupiter the displacement to be expected would reach about one-hundredth of the above.

E. H. B.

1469. *Doppler Principle for Moving Mirror.* **E. Budde.** (Phys. Zeitschr, 12. pp. 725–729, Sept. 1, 1911.)—A mathematical discussion of the Doppler principle for a moving mirror on the relativity theory, with special reference to an experiment by Klinkerfues. It is pointed out that, when the assumption is tacitly made that the reflection law suffers no disturbance of the first order of v/c by the motion of the mirror, the theory resulting is not in conflict with the experiment in question. E. H. B.

1470. *Small Longitudinal Material Waves accompanying Light-waves.* **J. H. Poynting.** (Roy. Soc., Proc. Ser. A. 85. pp. 474–476, Aug. 15, 1911.)—All experiments on the pressure of light agree in showing that there is a flow of momentum along the beam. This flow is manifested as a force on matter wherever there is a change of medium. When the light is absorbed the momentum is absorbed by matter. When the beam is shifted parallel to itself there is a torque on the matter effecting the shift. The momentum would therefore appear to be carried by matter and not merely by the ether. Though there is an obvious difficulty in accepting this view when the density of the matter is so small as it is in interplanetary space, it appears to be worth while to follow out the consequences of the supposition that the force equivalent to the rate of flow of momentum across a plane perpendicular to a beam of light acts upon the matter bounded by the plane. This rate of flow per cm.^{2} is equal to the energy per cm.^{3} in the beam. Of course, in experiments, only the average rate of flow during many seconds and the average energy per cm.^{3} in a length of beam of millions of miles is actually measured. But on the electromagnetic theory of light which suggested the experiments and which gives the right value for the pressure, this pressure is equal to the energy-density at every point of a single wave. It is then shown mathematically that if a beam of light is incident on any reflecting or absorbing surface, and if the pressure of light is periodic with the waves, it must give rise to ordinary elastic waves in the material, of frequency *double* that of the light-waves. Further, the ratio of energy in these longitudinal elastic waves to the electromagnetic energy of the light-waves is equal to one-eighth of the electromagnetic energy divided by the energy which the matter would have if it were moving with the velocity of light in that matter. E. H. B.

1471. *Group Velocities in a Dispersive Medium.* **M. Abraham.** (N. Cimento, 1. Ser. 6. pp. 448–454, June, 1911.)—If ω is the velocity of a periodic wave of length λ, then the group velocity is expressed by $\omega - \lambda d\omega/d\lambda$. Its reciprocal is given in a more convenient form by $1/\omega + \nu \,.\, d(1/\omega)/d\nu$, where v is the group velocity and ν the frequency. The author proves Reynolds's theorem for plane electromagnetic waves propagated in a dispersive medium. The problem is simpler than the hydrodynamic one, because all the points in a wave surface are at any instant in the same state, and the energy is propagated always at right angles to the wave surface. The theorem demonstrated links the group velocity with the mean densities of the energy and of the current of energy, and allows us to interpret it as the mean velocity of propagation of the rays in a dispersive medium. E. E. F.

1472. *Reflection of Light at certain Metal-liquid Surfaces.* **L. P. Wheeler.** (Amer. Journ. Sci. 32. pp. 85–100, Aug., 1911. Phil. Mag. 22. pp. 229–245, Aug., 1911.)—When light is incident on a transparent substance at an angle whose tangent has the numerical value of the index of refraction of the material, theory, as embodied in the Fresnel equations, demands that the reflected light should be plane polarised in the plane of incidence. Experience teaches, however, that but for a very few substances, solid or liquid, is this true. Most substances show at this angle an elliptic polarisation of small ellipticity (ellipticity being defined as the ratio of the amplitudes of the components of the vibrations parallel and perpendicular to the plane of incidence). Further, this ellipticity is found to be sometimes positive and sometimes negative. (Positive ellipticity is the counter-clockwise description of the ellipse when viewed from the side of the incident light.) That this well-nigh universal, though small, discrepancy between theory and experiment cannot be entirely assigned to contamination of the reflecting surface seems to have been definitely settled by the experiments of Rayleigh on very clean water surfaces [Phil. Mag. 5. 33. 1. 1892. See also Abstract No. 1778 (1908)]. He found that as the surface was made progressively cleaner, the negative ellipticity previously observed become numerically smaller, passed through a zero value, and for the cleanest surfaces obtainable assumed a very small positive value. On the other hand, Drude, working with the fresh cleavage surfaces of transparent crystals where the chance of surface contamination is very remote, found that within the limits of error of observation the ellipticity vanished (Wied. Ann. 36. p. 532, 1889). It would thus seem to be established that the theory stands in need of correction in the case of reflection from liquids, while remaining entirely competent in the case of solids. Now, the boundary conditions from which the equations of Fresnel are deduced assume an abrupt, discontinuous change in physical properties as we pass through the surface separating the two media. As such physical discontinuity is, *a priori*, highly improbable, it is natural to seek the source of the observed discrepancies in a thin transition layer where the two media interpenetrate and the physical properties change continuously, though rapidly, between the constant values they possess beyond the limits of the layer on either side. On this hypothesis it is natural to expect a thinner transition layer, and hence a closer approximation to the conditions of a discontinuous change, in the case of solids than of liquids. Thus, admitting that such layers must exist in all cases, we must conclude from the experiments mentioned that it is only in the case of liquids that they attain a sufficient thickness to be appreciable. But while the existence of the transition layer seems fairly certain, it is equally certain that the greater part of the divergencies of experiment from theory is due to films of surface contamination. Such films may be of the same order of thickness as the transition layer. But whereas the latter have an index of refraction, intermediate between those of the two chief media in question, the film may have an index outside those limits. Mathematically the effects from either the transition layer or the film can be thrown into identical form. The theory has been worked out by Drude (see Wied. Ann. 36. p. 865, 1889; also Wood's Physical Optics, p. 269, 1905), who showed that on the assumption of a film of thickness small compared with the wave-length of the light, its effect can be expressed as a correction term to the ordinary Fresnel equation. The form of this correction term shows that when the reflection takes place from the surface of a substance of greater index than that in which the light is incident, we should expect a positive ellipticity at the polarising angle for any film which has an index lying between those of the two media, and a negative ellipticity for a film with a greater index than that of either of the media. Thus a real transition layer can only produce a positive ellipticity; while a negative ellipticity must always be attributed to films of surface contamination with indices greater than that of the reflecting substance. Experiments were then made by the present author with mercury as the reflector. This was made to flow from a special thistle funnel whose upper surface was ground plane and set horizontal. To avoid any air-film between the mercury and the covering liquid, that liquid was present over the mercury in the funnel before the flow of mercury for cleaning the surface occurred. The liquids used over the mercury were three, viz., water, HCl, and turpentine. The results of the experiment in all three cases indicate that there was present no appreciable film or layer of any description; and consequently the transition layer which has been inferred for reflection in air is not independent of the medium with which the reflector is in contact. In other words, the transition layer is to be regarded as a true region of interpenetration of the media; and the fact that it is appreciable in liquids and not in solids must be attributed to the greater freedom of molecular motions in the case of the former, and not to any change in physical properties at the surface, brought about by the force of surface tension. E. H. B.

1473. *Relaxation of Caoutchouc, Gelatine, and Celluloid.* **P. Rossi.** (Accad. Sci. Fis. Mat. Napoli, Rendiconti, Nos. 5 and 6. May and June, 1911. N. Cimento, 2. Ser. 6. pp. 151–158, Aug., 1911. Extract.)—Calculating from the results of experiments previously published [Abstracts Nos. 1705 (1910) and 860 (1911)] the author shows that in caoutchouc subjected to constant strain, the optical and mechanical relaxations diminish with time in the same ratio, but no "time of relaxation," satisfying the exponential laws of Maxwell and Schwedoff, exists. The results obtained with gelatine and celluloid prove directly that for these substances the optical and mechanical relaxations have not the same velocity, that of the former being considerably the slower. W. H. St.

1474. *Theory of Diffraction Grating.* **C. Schaefer** and **F. Reiche.** (Ann. d. Physik, 35. 5. pp. 817–859, Sept. 1, 1911.)—A mathematical investigation of which the chief results may be summarised as follows: (1) If the diffraction grating stands in free space (without limitation by an opaque screen), then the diffraction spectrum differs from that usually observed. In general the character of the spectrum depends on the distance from the grating in suchwise that the phenomenon is periodically replaced by its complementary. Only in the central spectrum does the character of the phenomenon remain the same at all distances. (2) If the grating, standing in free space, consists of *very thin dielectric* bars, then it exhibits the Du Bois-effect; *i.e.*, it transmits a larger fraction of the radiation polarised at right angles to the grating bars than of the radiation polarised parallel to the bars. The reverse occurs if the grating consists of *very thin metallic* bars; such a grating shows the Hertz-effect. (3) The case usually realised in optics of a transmission grating occurring in an opaque screen differs essentially from the foregoing. The changes of the phenomena into their complementaries do *not* occur here; the character of the diffraction spectrum at great distances from the grating remains the same at all such distances. (4) The transmission grating of thin dielectric bars, by a suitable choice of scale and radiation, may be made to show either the Du Bois-effect, or the Hertz-effect, or the inversion-point between them. The same holds good for the metallic grating in the region of long waves. E. H. B.

1475. *Abbe's Theory of Microscopic Images.* **L. Mandelstam.** (Ann. d. Physik, 35. 5. pp. 881–897, Sept. 1, 1911.)—An investigation, partly mathematical and partly experimental, from which it is concluded that an incandescent particle behaves like an illuminated one which is illuminated equally from all sides. Thus Abbe's theory, in which the treatment was different for the incandescent and illuminated particles, may in certain cases be extended in its application to the class of particles for which it was not originally intended. E. H. B.

1476. *Perception of Brief Illuminations at the Limit of their Range.* **A. Blondel** and **J. Rey.** (Comptes Rendus, 153. pp. 54–56, July 3, 1911. Lumière Électr. 15. pp. 84–85, July 22, 1911. Illum. Engin., London, 4. pp. 557–562, Oct. *et seq.*, 1911. Journ. de Physique, 1. Ser. 5. pp. 530–550, July, 1911.)—The law limiting perception of very brief illuminations is found to be $(E - E_0)\,t = aE_0$, where E is illuminating power, E_0 the minimum illuminating power which is visible when the light is permanent, t the duration of illumination, and a is a constant, found experimentally to have a mean value of 0·21. The law formulated by Bloch in 1885, that for perceptibility the value Et is constant, applies only to very powerful lights, and is not generally correct. (Journ. de Physique, 1. Ser. 5. pp. 643–655, Aug., 1911.)—The law deduced above is only true for uniform flashes, but can be employed for non-uniform flashes by integrating between t_1 and t_2, the instants at which E becomes equal to E_0 at the beginning and end of each flash. Its application to intermittent signals is discussed. Considering the useful portion of the source of light to have a cylindrical form of diam. D, and a uniform intensity i, it produces a vertical concentration proportional to the useful height of the radiating surface h; and, assuming the light to be radiated uniformly, the apparatus would have a mean horizontal photometric intensity $I_{max} = khDi$, and the light received upon the pupil of an observer's eye would be $E_{max} = I_{max}\,f(x) = khiD\,f(x)$, where k is the coefficient representing loss

undergone by the rays in passage from the apparatus, x the distance of the observer away, and $f(x)$ the reduction of light due to the passage through this distance. Supposing the light flashes every T seconds, the quantity of light received by the pupil of the observer's eye $= khDiT\ f(x)$; here h and k are known from the construction of the apparatus, i and D are known from the nature and form of source of light selected, and T also has a fixed value.
W. H. Sı.

1477. *Absolute Measurement of Light.* **R. A. Houstoun.** (Roy. Soc., Proc. Ser. A. 85. pp. 275–284, June 9, 1911. Phys. Zeitschr. 12. pp. 800–806, Oct. 1, 1911.)—Seeing that the physiological peculiarities of the eye render it impossible to compare, rigidly, sources which differ in colour, the author advocates the use of a thermopile, protected by a special light-filter. Such a filter must have the property of weighting the different radiations according to their visibility so that the thermopile perceives light in the same manner as the normal eye. The author finds that a combination of two cells containing respectively aqueous solutions of copper sulphate and potassium dichromate answer this purpose, and he describes tests on glow-lamps carried out by this means. In conclusion, he advocates the definition of the unit of light as follows: The unit of light is that source the total intensity of which at an optical distance of 1 m., after passing through an ideal filter, would be x ergs/cm.^{2} sec., the ideal filter to be one possessing the light-absorbing properties of a 3-cm. thick aqueous solution of $CuSO_4 . 5H_2O$ of strength 0·200 gm.-mols. per litre and a 1-cm. thick aqueous solution of $K_2Cr_2O_7$ of strength 0·0025 gm.-mols. per litre, but neither to reflect nor to absorb light in any other way.
J. S. D.

1478. *Damping of Oscillations in Luminous and Non-luminous Sodium Vapour.* **G. v. Ubisch.** (Ann. d. Physik, 35. 4. pp. 790–816, July 25, 1911. Abstract of Inaug. Dissertation, Strassburg, 1911.)—Drude has theoretically deduced that the logarithmic decrement of the oscillations in sodium light must lie between $0{\cdot}6 \times 10^{-6}$ and $0{\cdot}6 \times 10^{-5}$. Mandelstam has given [Abstract No. 1598 (1910)] a simple method of experimentally determining this damping. Using this method, the damping of the oscillations was investigated both in luminous and non-luminous Na-vapour. For the latter a steel tube was used 80 cm. long and 3 cm. diam., the ends being closed with glass windows. A length of 5 cm. in the middle was heated by means of a coil wound round the tube, and in this portion was placed a small piece of metallic Na. The tube was water-cooled at both sides of this central portion. An iron-constantan thermo-element, protected from the action of the Na-vapour by a glass tube, gave the internal temperature. The tube was exhausted by means of a Kahlbaum pump, and the pressure (1 to 5 mm.) remained constant during one experiment. For the luminous vapour experiments a flame was used between the poles of a large Ruhmkorff electromagnet, as in Mandelstam's experiments. The logarithmic decrement of the oscillations in luminous sodium vapour was found to be of the order of magnitude 10^{-4}. The same result was obtained for non-luminous Na-vapour for low temperatures, corresponding to low densities. For higher temperatures, and consequently higher densities, in non-luminous Na-vapour a one-sided shifting or asymmetric splitting or shifting of the absorption lines occurs. This shifting is due to shorter wave-lengths.
A. W.

1479. *Dispersion of Quartz in the Ultra-red.* **F. Paschen.** (Ann. d. Physik, 35. 5. pp. 1005–1008, Sept. 1, 1911.)—Previous work by the author on some ultra-red line spectra has already been dealt with [Abstract No. 235 (1909)]. In the present paper the results are given of an accurate determination of the dispersion in the ultra-red of a quartz Cornu prism, 42 mm. high and 65 mm. along the polished face. The halves of the prism were brought by pressure into such good optical contact that very little light was reflected from the surface of contact. The wave-length scale was determined by Langley's bolometric method, and both optical and bolometric measurements of the refractive index were made, the results being compared with those of Rubens and Carvallo. The differences are exhibited graphically. Between 0·8 and 1·1 μ the refractive index as determined by Paschen follows the law of Rubens $n^2 = b^2 + M_1/(\lambda^2 - \lambda_1^2) - M_2/(\lambda_2^2 - \lambda^2)$, where $b^2 = 3{\cdot}4629$, $M_1 = 0{\cdot}010654$, $M_2 = 111{\cdot}47$, $\lambda_1^2 = 0{\cdot}010627$, and $\lambda_2^2 = 100{\cdot}77$. Further in the ultra-red Paschen's values for the refractive index are smaller than those given by the formula, for 2 μ by about 0·000090 and for 3 μ by about 0·00020. Carvallo's values for the refractive index agree with Paschen's at the beginning (0·67 μ) and at the end (2·17 μ) of his measurements, but between these wave-lengths are smaller than Paschen's values. The greatest difference, which is at 1·3 μ, is 0·00007. Probably the constants in the formula require altering. A. W.

1480. *Effect of Pressure on the Ultra-red Absorption Spectrum of Carbon Dioxide.* **G. Hertz.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 617–644, Aug. 15, 1911. Extract of Dissertation, Berlin.)—The author has extended the work of Angström, and of v. Bahr [Abstracts Nos. 224, 1868 (1909), and 1702 (1910)] on the effect of pressure on the absorption spectrum of CO_2. From measurements in the absorption region 14·7 μ it is shown that here also the absorption is dependent to a large extent on the total pressure, apart from the dependence on the thickness of the layer and the partial pressure, as was also found by Ångström and by v. Bahr for the short-wave absorption regions. It is also shown that it is not exactly the same if the total pressure is raised by compression of a small volume or by the admission of air or hydrogen. The conclusion of Rubens and Ladenburg [Abstract No. 1387 (1905)] that the absorption of the earth's radiation by the atmosphere does not suffice to explain the temperature variations of the surface of the earth, is *à fortiori* correct, since the CO_2 of the atmosphere is, in the higher layers, at a smaller total pressure, and accordingly its absorption is still smaller, as assumed by Rubens and Ladenburg. From further measurements in the regions 4·3 μ and 2·7 μ the results of Ångström and v. Bahr are confirmed. It is also shown that a difference exists between the effect of air and that of hydrogen on the absorption of CO_2. After the admission of air the same absorption is found as for pure CO_2 having the same total pressure and a correspondingly smaller thickness; the absorption in the case of hydrogen is somewhat greater. It is further shown that, as Paschen suspected, the absorption bands of CO_2 about 2·7 μ possess two maxima, which lie about 2·67 μ and 2·75 μ. The maximum about 2·67 μ is the greater of the two. A. W.

1481. *Electric Furnace Spectra under Pressure.* **A. S. King.** (Astrophys. Journ. 34. pp. 37–56, July, 1911. Contribution from the Mt. Wilson Solar Observatory, No. 58.)—Comparison spectra on a scale of 1 mm. = 0·95 Å. were made of several metals at various pressures from about 1 cm. of mercury to 11 atmos. The apparatus was similar to that described for previous work [Abstracts Nos. 60 and 234 (1909); 871 (1911)]. The results show a clear displacement of all lines to the red, the magnitude varying greatly for different lines. The lines showing the largest displacements are those appearing at the highest temperatures, and these show distinctly less widening than the low-temperature lines. In the case of iron the displacements are found to occur in groups with shifts in the ratios of 1 : 2 : 4, similar to those found by Duffield in the arc spectrum. For the same pressure it is found that the furnace shifts are much larger than those of the arc, in many cases as much as 100 per cent.

C. P. B.

1482. *Arc Spectrum of Vanadium under Pressure.* **R. Rossi.** (Astrophys. Journ. 34. pp. 21–25, July, 1911.)—Working in similar manner to that previously described for titanium [Abstract No. 908 (1910)], the spectrum was observed at various pressures from 15 to 100 atmos. All the lines were widened and displaced towards the red by the action of the increased pressures. The displacements do not vary much from line to line, so that any division into groupings was impossible. The relative intensities of the lines are little affected. C. P. B.

1483. *Anode and Kathode Spectra of Gases and Vapours.* **G. Stead.** (Roy. Soc., Proc. Ser. A. 85. pp. 393–401, Aug. 15, 1911.)—A cylindrical discharge tube was used in the experiments, the length of the tube being about 25 cm.; various diameters were tried, varying from about 0·3 cm. to about 1 cm. The tube was divided into two halves by a small plate of Al (0·5 cm. thick), which fitted sufficiently well to cause the discharge to go through it and not round it. In these circumstances one side of the plate forms an anode and the other a kathode, so that a small shift either of the tube or the spectroscope suffices to bring one or the other electrode before the slit. A "point and plane" spark-gap was placed in series with the tube to minimise the effect of reversals. A considerable number of gases and vapours were examined, and the results show that the spectra of electro-negative elements tend to appear at the anode, whilst the spectra of electro-positive elements show a preference for the kathode. The explanation of these facts is most likely to be found in (i) the difference in potential gradient and temperature at the two electrodes; (ii) the electro-chemical properties of the elements concerned. A. W.

1484. *Wave-lengths of Lines in the Secondary Spectrum of Hydrogen.* **C. Porlezza.** (Accad. Lincei, Atti, 20. pp. 176–183, Aug. 20, 1911.)—Continuing his investigation of the secondary spectrum of hydrogen [Abstract No. 1131 (1911)], the author gives the wave-lengths and intensities of 48 lines not previously observed, between $\lambda = 6563·05$ and $\lambda = 6962·82$, together with a complete list of lines in the orange-red portion of the spectrum between $\lambda = 6563·05$ and $\lambda = 6082·14$, 68 lines in the ultra-violet region between $\lambda = 3889·16$ and $\lambda = 3295·49$, and a number of lines between $\lambda = 4807·49$ and $\lambda = 4253·48$. W. H. Si.

1485. *Investigation of Absorption Lines with Echelon Grating.* **C. Füchtbauer.** (Phys. Zeitschr. 12. pp. 722–725, Sept. 1, 1911. Paper read before the Deutsch. Naturforscherversamml., Salzburg, 1909.)—The author has developed a method of investigating absorption lines by means of the echelon grating, and employed this method to find the effect on the absorption lines of a gas, of other gases admitted to the vessel containing it. Light from an Heræus mercury lamp was condensed on the vessel containing the gas under investigation, which was placed in front of the slit of a constant-deviation spectroscope, the echelon spectroscope being arranged in the usual manner in line with the telescope tube of the former. Using bromine vapour at 1 cm. pressure, a group of 8 fairly sharp lines is obtained. The effect on these of admixtures of air, CO_2, nitrogen, and hydrogen is by no means the same, though CO_2 and nitrogen have similar effects to air. Hence and from other experiments it is concluded that the broadening of the lines depends not only on the pressure, but also on the nature of the admixed gas. Bands and series lines seem to be affected differently. Quantitative measurements were made by photographic photometry. [See also Abstract No. 1505 (1907).] A. W.

1486. *Series Systems in the Spectra of Zinc, Cadmium, and Mercury.* II. **F. Paschen.** (Ann. d. Physik, 35. 5. pp. 860–880, Sept. 1, 1911.)—A continuation of the author's work [see Abstract No. 245 (1910)]. The principal series of simple lines, corresponding to the two subordinate series already investigated, is given, the three series thus corresponding to those in the spectrum of Mg. A quartz lamp was employed and the photographic plates were specially prepared so that lines up to 8200 Å could be measured. The principal series found is connected with the ultra-red line $m = 2{\cdot}5$ of the second subordinate series. But it could be shown that another member, $m = 1{\cdot}5$ of the second subordinate series, exists in the ultra-violet. This member was found by means of the exceptionally strong lines Zn 2138·6, Cd 2288·1, Hg 1849. The demonstration was brought about through the existence of a combination series by means of which strong, and up to the present unclassified, lines of the three elements were in a similar manner arranged in series. The magnetic separation of these newly arranged lines was investigated and some interesting information thereby obtained with reference to Rydberg's doublets in Zn, Cd, and Hg. The results show the indubitable existence for Zn and Cd of the different systems of series: simple lines, doublets, and triplets. The three spectra all show correspondingly strong combinations between the triplets and the simple lines. For the demonstration of these the exact value of the series limits must be known. For the combinations within a single system the limit of a series can be, as is well known, taken arbitrarily. From the superior accuracy obtained with the combinations $2{\cdot}5\,s - m\,.\,\mathrm{P}$ and $2p_2 - m\,.\,\mathrm{S}$ it follows that the limits were very accurately determined. A. W.

1487. *Thulium.* **C. A. v. Welsbach.** (Zeitschr. Anorg. Chem. 71. 4. pp. 439–440, Aug. 10, 1911.)—From a spectroscopic investigation of thulium preparations it appears that thulium consists of three elements, to which the author assigns the symbols TuI, TuII, and TuIII. All three give characteristic absorption and spark spectra, which are noted. Other elements possibly lie between aldebaranium and TuI, and between TuII and TuIII. A. W.

1488. *Ultra-violet Spectrum of Silver Iodide.* **C. Schell.** (Ann. d. Physik 5. 4. pp. 695–726, July 25, 1911. Extract of Dissertation, Leipzig.)—Describes a series of photographic photometric measurements of absorption in the ultra-violet spectrum of silver iodide. The photographic method is described at length, and presents some points of interest. It is shown that the irregularities of the developed photographic plate are due to variations of concentration of the developer, but the irregularities can be eliminated by using a slow developer and soaking the plate previously in water. The blackening curves for different wave-lengths with normal illumination are not parallel straight lines, but the slope falls off much more with decreased wave-length. The absorption coefficient of silver iodide was determined for the spectral region 215 to 450 μμ, 12 mirrors being silvered by kathodic deposition and 8 chemically. The absorption curve shows three maxima, at wave-lengths 422·6, 322·2, and 271·2 μμ. The absorption coefficients for these three points are respectively 0·460, 0·428, 0·609. Calculation from Schell's formula, for the first of these gives a value for the absorption coefficient of 0·454. [See also Abstracts Nos. 1786 (1900) and 495 (1901).] A. W.

1489. *Europium.* **C. James** and **J. E. Robinson.** (Amer. Chem. Soc., Journ. 33. pp. 1363–1365, Aug., 1911.)—In order to obtain a sufficient quantity of the substance for further study, very large amounts of material were worked up. This material comprised the following: Oxides from insoluble double sodium sulphates from about 200 kg. of yttrium minerals; all the samarium and gadolinium oxides derived from about 200 kg. of Brazilian monazite; and about 110 kg. of oxides obtained from the more soluble double potassium sulphates coming from very large amounts of Carolina monazite. These crude oxides were first converted into double magnesium nitrates, which were fractionally crystallised according to the usual method with 30 per cent. nitric acid as the solvent. As the work of separation proceeded, the europium absorption band (a fine blue band shown by the gadolinium fractions next to samarium) was observed to become stronger. Later the two bands in the green made their appearance. Finally, about 100 gm. of europium oxalate were obtained, which was freed from samarium by a further series of crystallisations, then washed, dried and stored for the study of its compounds. About 5 kg. of pure samarium oxalate and about 4 kg. of nearly pure gadolinium oxalate were also prepared. Further work will be described in a subsequent paper. A. W.

1490. *Holmium.* **O. Holmberg.** (Zeitschr. Anorg. Chem. 71. 3. pp. 226–235, July 7, 1911.)—The paper gives a *résumé* of previous work on the isolation and properties of holmium, and also the results of the author's research. Fractionation methods were employed to obtain the pure oxide, and atomic weight determinations gave a mean value of 163·5. The absorption spectrum was investigated for bi-normal and semi-normal nitrate solutions of 10 cm. thickness. The results showed that the holmium material was practically freed from erbium, and dysprosium occurred in only extremely small quantity. Hence the atomic weight determinations are reliable. Holmium oxide has a faint yellow colour and the salts are also yellow, with a tinge of orange. A. W.

1491. *Homogeneous Röntgen Radiation from Vapours.* **J. C. Chapman.** (Phil. Mag. 21. pp. 446–454, April, 1911.)—The value of λ/ρ in Al of the homogeneous secondary X-radiation from bromine, has been determined for vapour of ethyl bromide, solid sodium bromide, and bromine hydrate, and found to be 16·3. Vapour of ethyl iodide and solid iodine gave the value 2·8 for λ/ρ. The amount of secondary radiation from ethyl bromide when hydrogen and CO_2 respectively were used to convey the vapour was nearly the same. This disproves the theory that the secondary X-radiations result from the bombardment of the atoms by ejected corpuscles; for CO_2 would absorb the corpuscles far more than hydrogen, so that in the latter gas more secondary X-radiation should be generated. L. H. W.

1492. *Intensity of Secondary Homogeneous Röntgen Radiation from Compounds.* **J. C. Chapman and E. D. Guest.** (Cambridge Phil. Soc., Proc. 16. pp. 136–141, May 18, 1911.)—The paper deals with quantitative experiments on the amounts of secondary characteristic X-radiations emitted from different compounds of the same element. The materials used, salts of strontium and tin, were placed on a shallow tray in the path of a beam of Röntgen rays of standardised intensity, and the increase in the amount of secondary radiation from the tray was measured, allowance being made for the absorption of the layer of material. The results show that the intensity of the homogeneous secondary radiation depends merely on the quantity of the emitting element present and is independent of its combined state.

E. M.

1493. *Attempt to detect Fatigue Effect in the Production of Secondary Röntgen Radiations.* **J. C. Chapman.** (Cambridge Phil. Soc., Proc. 16. pp. 142–147, May 18, 1911.)—In the experiments described, a beam of Röntgen rays fell on a metal cylinder which could be rotated at high speed about its axis. The secondary radiations from the cylinder in a direction at right angles to the axis were measured in an electroscope placed outside the primary beam, when the cylinder was stationary or revolving in either direction. Cylinders of Zn, Cu, and Al were used, the two former giving characteristic secondary radiations. In no case was there any alteration of the secondary radiation produced by rotation, indicating no fatigue effect even when the time for recovery was only 1/600 sec. Further, the results with Al show by calculation, that the vibrating system causing the scattered radiation is very rapidly damped and does not continue in sufficient strength to emit 1/50 of the original radiation after a period of 1/8500 sec.

E. M.

1494. *Scattering of Röntgen Radiation.* **E. A. Owen.** (Cambridge Phil. Soc., Proc. 16. pp. 161–166, May 18, 1911.)—A narrow beam of X-rays was allowed to fall on a thin radiator of filter-paper and the distribution of the scattered radiation round the radiator was investigated from the points of view of (1) the hardness of the primary beam, and (2) the thickness of the radiator [see Abstracts Nos. 477, 618 (1911)]. The results show that the distribution on the incident side of the radiator in all cases agrees closely with the theoretical distribution given by the relation $I\phi = (I\pi/2)(1 + \cos^2\phi)$, where ϕ is angle made with the normal. In the case of the hardest rays examined (equivalent spark-gap 7 cm.) the same theoretical distribution is also obtained on the emergent side. A dissymmetry, however, appears when the rays become softer, and this increases with the softness of the rays and also increases slightly with the thickness of the radiator, absorption being allowed for. If, however, the thickness of the radiator is increased beyond a certain limit, the dissymmetry, or relative excess of the emergent radiation over the incident, becomes less pronounced. A possible explanation of the foregoing results is that the softer rays in the primary beam are irregularly refracted and become diffused.

E. M.

1495. *Ionisation of Heavy Gases by X-rays.* **R. T. Beatty.** (Roy. Soc., Proc. Ser. A. 85. pp. 230–239, June 9, 1911.)—The results of Barkla and Sadler have shown that characteristic X-rays are produced in a substance by incident X-rays when the latter are more penetrating than the former, and also that the corpuscular radiation from the substance is greater when it is emitting its characteristic X-radiation than when the characteristic radiation is not excited [Abstract No. 686 (1910)]. The present paper deals with the quantitative relation between these various radiations in the case of certain gases, and with the mechanism involved in the conversion of the energy of X-rays into energy of ionisation [see next Abstract]. The results show: (1) When X-rays pass through AsH_3, SeH_2, or $Ni(CO_4)$ a large part of the ionisation produced is due to the production of corpuscular rays; (2) the corpuscular rays are produced in the same quantity from these substances whether they are in the solid or the gaseous condition. The case of SeH_2 has been more closely examined, and results are given for the difference between the whole ionisation produced by X-rays of varying penetrabilities and the amount of ionisation due to the corpuscular rays evoked. These differences may be due to the direct formation of ions by the incident X-rays, to a discharge of δ-rays from the atom at the moment when the corpuscle leaves it, or to a similar discharge due to the disturbances produced in the atom by the excitation of the characteristic radiation. E. M.

1496. *Energy-transformations of Röntgen Rays.* **W. H. Bragg** and **H. L. Porter.** (Roy. Soc., Proc. Ser. A. 85. pp. 349–365, July 5, 1911.)—Bragg's corpuscular theory of X-rays leads to the supposition that (1) the production of kathode rays should follow from the disappearance of X-rays of like energy, and (2) that the former should alone be the cause of ionisation [Abstract No. 1716 (1910)]. In the experiments described, Röntgen rays were allowed to fall on tin and the resulting characteristic secondary X-rays caused to fall on different substances. The quantities of kathode radiations emerging from the substances were measured, and from the results the amount of kathode radiation actually produced in a given weight of material through the absorption of a given quantity of X-radiation was calculated. The amounts of kathode radiation were then compared with the absorption coefficients of the secondary X-rays by the materials. The results support the deduction (1) given above, showing, for example, that secondary X-rays produce equal kathode radiations in oxygen and silver for equal expenditures of energy. It was then shown that when X-rays pass through oxygen the kathode radiations in the gas are sufficient to account for all the observed ionisation, this being in agreement with the latter deduction (2) given above. E. M.

1497. *Production of Characteristic Röntgen Radiations.* **R. Whiddington.** (Roy. Soc., Proc. Ser. A. 85. pp. 323–332, July 5, 1911. Cambridge Phil. Soc., Proc. 16. pp. 150–154, May 18, 1911.)—The paper deals mainly with the characteristic X-radiations emitted by various materials on which Röntgen rays are falling. A homogeneous stream of kathode rays was separated out by a magnetic field and directed on to an antikathode. The primary Röntgen rays so produced were allowed to fall on a secondary radiator and the quality of the secondary radiation was investigated by its penetrating power. It was found that the characteristic radiation of the secondary radiator of atomic weight w is only emitted when the velocity of the parent kathode ray exceeded $w \times 10^8$ cm./sec. It was also found that the energy emitted in the form of Röntgen radiation by a kathode particle when suddenly stopped at the antikathode is proportional to the fourth power of its velocity. This latter result agrees with the theoretical calculation of J. J. Thomson. E. M.

1498. *Spectra of the Fluorescent Röntgen Radiations.* **C. G. Barkla.** (Phil. Mag. 22. pp. 396–412, Sept., 1911.)—When substances are exposed to Röntgen radiation they emit X-radiations of two distinct types. One of these radiations, like the primary in penetrating power and general properties, has been termed the scattered radiation, being analogous to light scattered from small particles. The other, a completely transformed X-radiation, has been termed the characteristic secondary X-radiation, the homogeneous secondary X-radiation, and latterly the fluorescent X-radiation, on account of its similarity to fluorescent light. This paper gives an account of the existing state of knowledge relative to the fluorescent X-radiation, without entering into details of experiments. A. E. G.

1499. *Transformation of Energy of Homogeneous Röntgen Radiation into Energy of Corpuscular Radiation.* **C. A. Sadler.** (Phil. Mag. 22. pp. 447–458, Sept., 1911.)—In a previous paper the author has described experiments on the corpuscular radiation from metals excited by beams of homogeneous Röntgen radiation. The present paper deals mainly with further deductions from these experiments. It is shown that there is strong evidence that whenever a characteristic X-radiation is excited, there is always produced a strictly proportional amount of corpuscular radiation. The results also suggest that corpuscles are shot out of a substance when it scatters Röntgen radiation, as well as when it emits a characteristic radiation. E. M.

1500. *Variation of Ionisation with Velocity for β-Particles.* **W. Wilson.** (Roy. Soc., Proc. Ser. A. 85. pp. 240–248, June 9, 1911.)—β-Rays of different velocities were separated out by a magnetic field from the heterogeneous beam given out by RaB and RaC. The total charge carried by the particles of each velocity was measured and also the corresponding ionisation produced, and thus, as each β-particle carries the same charge, the relative ionisation per particle at different velocities was calculated. The results show that the ionisation per cm. of path is inversely proportional to the square of the velocity of the particle, the velocities in the experiments ranging from 1·8 to $2·9 \times 10^{10}$ cm./sec. The ionisation in a small thick copper vessel, however, was found to be not connected with the velocity by any simple power law, but approximately given by $I = k(c - v)$, where k and c are constants and v is the velocity of the β-particles. E. M.

1501. *Delta Rays and Self-charge of Polonium.* **F. Hauser.** (Phys. Zeitschr. 12. pp. 466–476, June 15, 1911.)—The paper deals with various experiments on the properties of the δ-rays emitted from a plate coated with polonium. The plate was charged to a negative potential, and it was found that the rate at which negative electricity was carried away by the δ-rays was the same as previously, while when charged to a sufficiently high positive potential the δ-rays were stopped and forced to return to the plate. The author thus concludes that a radio-active body will by ideal isolation charge itself to a potential $\pm E$ such that the values of $\mp e/m$ and v of the emitted rays correspond to the equation $eE = \frac{1}{2}mv^2$. Further results showed that the number of δ-particles given off from the poloniumised brass plate was independent of the air pressure and amounted to about 60 per α-particle; while the number of secondary particles excited when the α-particles fell on brass amounted to 17 per α-particle. Further, when the polonium was covered with Al-foils the max. number of secondary particles emitted was about 20 per α-particle. The penetrating power of the polonium δ-rays was measured and found to be from $\frac{1}{15}$ to $\frac{1}{4}$ that of the α-particles. E. M.

1502. *Delta Rays.* **N. Campbell.** (Phil. Mag. 22. pp. 276–302, Aug., 1911.)—The paper deals with the properties of the slow-moving electrons emitted by a plate on which polonium has been deposited, and with the question as to whether they are other than a secondary effect due to the expulsion of α-particles [see preceding Abstract]. The method of experiment was to place two bodies coated with polonium in such a position in vacuum that all the δ-particles emitted by one could strike the other (in the absence of electric or magnetic fields). One plate was kept at zero potential, and the current received by it was measured for various potentials of the other. The results show no evidence that the speed of the δ-particles is dependent on (1) the speed of the α-particles exciting them; (2) the material from which they are emitted; and (3) whether they are emitted directly by the poloniumised plate or as the secondary effect of α-particles falling on it. The experiments also indicate that the number of δ-particles is not dependent on the material of the poloniumised plate. In an appendix the author describes the construction of high resistances, of the order 10^{11} ohms, consisting of mixtures of xylol and absolute alcohol contained in glass tubes. E. M.

1503. *Radio-activity of the Air over the Sea.* **C. Runge.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 99–109, 1911.)—The author has made observations of the activity collected on a charged wire exposed to the atmosphere on a voyage to the West Indies. The amount of activity under the same conditions was found to be nearly as large over the ocean as near the coast, while decay observations showed it to be of the same nature, evidence being obtained of the presence of thorium active deposit. E. M.

1504. *Amount of Radium Emanation in the Soil and its Escape into the Atmosphere.* **J. Joly** and **L. B. Smyth.** (Roy. Dublin Soc., Proc. 13. 11. pp. 148–161, Aug., 1911.)—The results of Eve and Satterly show that about 80×10^{-12} gm. is the average amount of Ra in equilibrium with the RaEm contained in 1 m.^{3} of the atmosphere. As the RaEm decays to half value in 3·85 days it must be recuperated from the earth at a rate of 2880×10^{-12} per hour per m.^{2} of the earth's surface. In order to investigate how far this condition is fulfilled the authors have investigated (*a*) the amount of RaEm contained in the gases diffused through the soil; (*b*) the amount escaping from the surface of the soil. To investigate (*a*) a hollow iron plug with holes at the bottom was driven into the ground to various depths and air sucked through it and its RaEm-content measured. The average content was found to be several thousand times the average RaEm-content of the atmosphere, and varied for different days and localities. To investigate the amount of Em escaping from the soil, an arrangement was used by which a slow current of air was passed over the surface of the soil and thence over cocoanut charcoal which absorbed the Em. The results varied for different localities, for whereas at College Park (Dublin) the amount calculated above, 2880×10^{-12}, was in no case reached, yet at Milltown it was generally largely exceeded. From a consideration of the whole results the authors conclude that the gases exhaled from the soil are the chief and probably the only considerable source of the emanation found in the atmosphere. E. M.

1505. *Amount of Radio-active Products present in the Atmosphere.* **S. Kinoshita, S. Nishikawa,** and **S. Ono.** (Mathematico-Physical Soc., Tokyo, Proc. 6. 6. pp. 92–111, June, 1911.)—In the experiments described wires were exposed at a high negative potential to the atmosphere, and the decay curves of the resulting activity analysed with a view to finding the relative amounts of RaEm and ThEm present and to elucidate the procedure of deposition of the active matter. The results show that particles of RaA and ThA are deposited, but not other products such as RaB, RaC, &c. According to the theory put forward the amount of RaEm present in the atmosphere at Tōkyō is 5×10^{-13} Curies per m.^{3} [see preceding Abstract], while, assuming the amount of ThEm per unit volume is the same at equal heights, the ratio of the amount of RaEm to ThEm is found to be 18,000 : 1 at a height of 6·5 m., and 6500 : 1 at a height of 1·5 m. E. M.

REFERENCES.

1506. *Camera for Complete Panoramic View.* **S. Nakamura.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 7. pp. 114–119, July, 1911.)—A circular camera is provided with a hollow central pivot which carries the lens and two reflectors arranged at 45° to the lens axis so that an outside view is projected on the film placed round the interior cylindrical surface. C. P. B.

1507. *The Biotar: a Projection System with very Large Aperture.* **M. v. Rohr.** (Zeitschr. Instrumentenk. 31. pp. 265–270, Sept., 1911. C. Zeiss' Works' Communication.)

1508. *Liquid Condensing Lenses of Large Aperture.* **A. Köhler.** (Zeitschr. Instrumentenk. 31. pp. 270–276, Sept., 1911. C. Zeiss' Works' Communication.)

1509. *Speeds Beyond that of Light.* **W. v. Ignatowsky.** (Phys. Zeitschr. 12. pp. 776–778, Sept. 15, 1911.)—A mathematical treatment on the basis of the relativity theory. [See Abstracts Nos. 2277 (1905), 1570 (1910), and 844 (1911)]. E. H. B.

1510. *Small Sympathetic Vibrations detected by Interference Methods.* **J. S. Stevens.** (Amer. Journ. Sci. 32. pp. 231–232, Sept., 1911.)—Describes the detection, by a Michelson interferometer, of forced vibrations of very small amplitude. E. H. B.

1511. *On Absorption and Dispersion.* **A. Stephenson.** (Phil. Mag. 22. pp. 303–305, Aug., 1911.)—A discussion of the energy dissipation characteristic of a medium in the molecule of which the normal motions of the visible spectrum are subject to the influence of other normal motions of relatively small frequency. L. H. W.

1512. *Consequences of Fresnel's Reflection of Light Theory.* **R. B. Sangster.** (Phil. Mag. 22. pp. 305–322, Aug., 1911.)—The paper gives formulæ for determining the angle of incidence in order to reflect 1/*n*th of the incident light.

1513. *The Selective Reflection of Ortho-, Meta-, and Pyro-phosphates in the Infra-red.* **G. Langford.** (Phys. Rev. 33. pp. 137–151, Aug., 1911.)

1514. *Michelson's Interference Experiment.* **F. Grünbaum.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 584–589, Aug. 15, 1911.)—Now that this classical experiment is so often taken as the starting-point of the relativity theory, the author deems it desirable to discuss the exact details of its setting up and interpretation. This is here carried out by the aid of six diagrams. Reference is also made to the light thrown upon the matter by M. Laue [see Abstract No. 1611 (1910)]. (*Erratum* Ibid. 13. 17. p. 694, Sept. 15, 1911.) E. H. B.

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1515. *Isopiestic Expansibility of Water at High Pressures and Temperatures.* **W. Watson.** (Roy. Soc. Edinburgh, Proc. 31. pp. 456–477, 1910–1911.)—Experiments were made by the author on the expansibility of water at high temperatures and pressures, employing a compression cylinder designed by Des Coudres, and a specially designed dilatometer made of quartz glass. The measurements were made, in some cases, up to a temperature of 1000° C. The main conclusions are: (1) The rate of change of volume with temperature, increases continuously with the temperature up to a maximum, the value of which decreases with increase of pressure. (2) While in the liquid state, water under high pressures and at temperatures above 240° C. obeys the ordinary laws of dilation of liquids. (3) Almost immediately after entering into the gaseous state, water, at high pressures, behaves as a substance the coefficient of expansion of which is independent of the temperature and decreases with increase of pressure. It behaves, therefore, like such gases as oxygen, nitrogen, and hydrogen at the same pressures, but at lower temperatures. F. J. B.

1516. *Specific and Latent Heats of Metals at High Temperatures.* **H. C. Greenwood.** (Engineering, 92. p. 419, Sept. 29, 1911. Erratum, ibid. p. 458, Oct. 6, 1911. Paper read before the British Assoc. at Portsmouth.)—The author has rendered J. Harker's electric furnace (in the National Physical Laboratory) entirely automatic. The furnace swings round and returns to its previous position; the specimen is dropped into the calorimeter when a suspension loop of Pt-wire fuses. The specimen is sealed up in a silica tube and falls, not directly into the calorimeter water, but into a funnel-shaped brass tube charged with calcined precipitated magnesia hydrate which forms a very light powder, behaving like a liquid. The mean specific heat curve of zinc is continuous below and above the melting-point, and the latent heat of fusion is 26 gm.-cals. per gm. of zinc. Aluminium attacks silica above 750° C. and can be powdered near its melting-point; just before that point the specific heat curve bends sharply upward; the latent heat of fusion is 93 gm.-cals. H. B.

1517. *Specific Heats of Various Gases and Vapours.* **R. Thibaut.** (Ann. d. Physik, 35. 2. pp. 347–377, June 29, 1911. Extract of Dissertation, Berlin.)—The investigations include a determination of $k = C_p/C_v$ by the Kundt method as modified by Behn and Geiger, and a direct measurement of C_p by the streaming method; the gases were heated in an electric heater similar to that employed by Nernst. The results obtained were in harmony with the previous determinations, and showed that: (1) The value for k at 1 atm. is frequently different to a considerable extent, from the value at $\frac{1}{3}$ atmo. (2) When C_p is very large, a serious error is introduced if k is measured with a view to determining C_p. This is caused by the errors in the determination of k exerting a considerable influence upon the value found for C_p. (3) At high temperatures C_p is greater, the greater the number of atoms in the molecule. (4) For the same number of atoms C_p is greater, the greater the molecular weight. (5) C_p rises the more rapidly with the temperature, the greater is the number of atoms compared with the molecular weight. (6) The molecular heats of CO_2 and SO_2, of H_2O and H_2S are practically the same, but this is not the case for CO_2 and CS_2. F. J. B.

1518. *Specific Heat of Gases.* **H. Bjerrum.** (Zeitschr. Elektrochem. 17. pp. 731–734; Discussion, pp. 734–736, Sept. 1, 1911. Paper read before the 18. Hauptversamml. d. Deutsch. Bunsen-Gesell, Kiel, May, 1911.)—Einstein had given a formula for the specific heat of solids based upon the entities (quanta) theory. Nernst and Lindemann modified this formula and extended it to gases. The author indicates the line of argument, gives data for H, N, CO_2, aqueous vapour, which confirm Nernst-Lindemann, and shows that for CO_2, at any rate, the variations of the specific heat with temperature can be calculated from Boltzmann's theory and the absorption bands of the spectrum, in accordance with Einstein. In the *discussion*, **W. Nernst** pointed out that the slow cooling of the sun might be due to the enormous specific heat of vapours of iron, &c. (spectra characterised by many lines), at the very high solar temperatures. H. B.

1519. *Curious Thermal Phenomenon.* **E. G. Bryant.** (Chem. News, 104. p. 96, Aug. 25, 1911.)—The writer has observed that when a porcelain dish covered internally with a layer of paraffin wax is heated until the wax melts about three-quarters of the way up the sides, and the dish is half-filled with cold water after removing the flame, there is a sudden extension of the melted zone towards the edges of the dish. Confirmation and an explanation of this curious phenomenon are requested. (Ibid. p. 118, Sept. 8, 1911.)—The phenomenon has been confirmed by watching the changes in a thin coating of red mercuric iodide on a metal bar which is alternately heated and cooled at one end. Apparently the changes are more distinct when slower cooling is resorted to, indicating that the changes are more or less cumulative.

F. C. A. H. L.

1520. *An Optical Method of Measuring Vapour Pressures.* **C. Cuthbertson** and **M. Cuthbertson.** (Roy. Soc., Proc. Ser. A. 85. pp. 306–308, June 9, 1911.)—The refractivity of gaseous bromine was found to change with the temperature, and it was shown to be possible to measure these changes rapidly and accurately by a Jamin refractometer. The method was found to be applicable to the determination of vapour pressures of substances which attack mercury, and by aid of it the vapour pressures of solid Br were determined, from a temperature of −80° to −7·1° C. The results show that the vapour pressures measured, fall on an exponential curve $p = ab^{\theta}$, and the values for a and b are found to be $a = 2{\cdot}485 + 10^{-8}$ and $b = 1{\cdot}0884$. The optical method seems to be especially adapted for investigation of the changes of vapour pressure which occur at the solidifying point. F. J. B.

1521. *Isotherms of Monatomic Substances and of their Binary Mixtures. X. Behaviour of Argon with respect to the Law of Corresponding States (continued).* **H. Kamerlingh Onnes** and **C. A. Crommelin.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 158–163, Aug. 28, 1911. Communication No. 121*b* from the Physical Lab., Leiden.) [See Abstracts Nos. 501 and 778 (1911)].)—This paper contains a comparison of the argon isotherms with those obtained from the mean reduced equation of state, and with those for isopentane. The diagrams given show that there are systematic differences between argon and ordinary normal substances, in particular isopentane, which are probably due to the monatomic argon molecules being less compressible than the polyatomic molecules of isopentane. T. S. P.

1522. *Temperature Measurements by aid of the Clapeyron-Clausius Equation.* **F. Henning.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 645–650, Aug. 15, 1911.)—The author employed the Clapeyron-Clausius equation in a modified form to measure temperatures, measuring volumes and pressures directly. Up to a temperature of 140° there is an excellent agreement between the values so obtained and those given by gas-thermometer measurements. At higher temperatures the error increases, but still remains within comparatively small limits. F. J. B.

1523. *Isotherms of Monatomic Substances and of their Binary Mixtures. XI. Critical Temperature of Neon and the Melting-point of Oxygen.* **H. Kamerlingh Onnes** and **C. A. Crommelin.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 163–165, Aug. 28, 1911. Communication No. 121*c* from the Phys. Lab., Leiden.)—Observations on the behaviour of neon at —218·4° show that the critical point lies at least some degrees below —218° C. The melting-point of oxygen is found to be —218·4° C., whereas Estreicher has stated it to be —227° C. T. S. P.

1524. *Thermal Molecular Motions in Solids.* **A. Einstein.** (Ann. d. Physik, 35. 4. pp. 679–694, July 25, 1911.)—The author has previously shown [Abstract No. 489 (1907)] that some relation must hold between the radiation law and the law of specific heat of solid bodies. The researches of Nernst and his school have now shown that the specific heat follows, in the main, that obtained from the radiation theory, but that the true law of specific heat systematically deviates from that theoretically derived. It is the first object of the present paper to point out that these deviations may be due to the fact that the vibrations of the molecules are far removed from being monochromatic. Also the thermal capacity of an atom of a solid is not equal to that of a slightly-damped, but rather like that of a strongly-damped oscillator in the radiation field. It is also shown, by consideration of dimensions, that the thermal conductivity of a monatomic substance must depend on the atomic weight, atomic volume, and vibration frequency. E. H. B.

REFERENCES.

1525. *Further Experiments with Liquid Helium. E. A Helium Cryostat. Remarks on Preceding Communications.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 204–210, Aug. 28, 1911. Communication No. 123*a* from the Phys. Lab., Leiden.)—A description of a helium cryostat which, although in close connection with the liquefier, allows the ready introduction of apparatus into the helium bath, at the same time leaving a free and independent exit above the bath. T. S. P.

1526. *Thermostat for Controlling the Temperature of a Room.* **Berkeley** and **C. V. Burton.** (Phil. Mag. 22. pp. 211–214, July, 1911.)—Of the bimetallic type with relay. L. H. W.

1527. *On the Constant of Radiation.* **C. Féry** and **M. Drecq.** (Journ. de Physique, 1. Ser. 5. pp. 551–560, July, 1911. Paper read before the Soc. franç. de Physique, April 7, 1911.)—The full paper corresponding to Abstract No. 905 (1911).

SOUND.

1528. *Pianoforte Bridges.* **G. H. Berry.** (Phil. Mag. 22. pp. 113–118, July, 1911.)—In every pianoforte there are two bridges: one which may be called the fixed bridge, which is the higher in the Upright pianoforte and nearer the keyboard in the Grand; the other may be called the free bridge, and is glued and screwed direct to the soundboard in both types of instrument. The fixed bridge is usually of metal and forms part of the framing of the pianoforte. It is practically rigid and not directly connected to the soundboard, and therefore plays no part in communicating the vibrations of the string to the soundboard. It is used to determine the vibrating length of the string and the striking-point of the hammer. The experiments here recorded deal with the free bridge, instantaneous photographs being taken showing displacement-time curves for the soundboard. A possible rocking motion of the bridge which would put the two parts of the soundboard in opposite phases is then shown to be absent, for the two parts in question are in the same phase. The paper concludes with a mention of the soundless vibrations of a pianoforte string, which may be observed by placing a weight on the lowest key of the instrument and then plucking the string with the fingers. The sound thus produced lasts about 10 or 15 seconds, then the string inaudibly, though visibly, vibrates for another 80 seconds. The original vibration has components perpendicular and parallel to the soundboard: the former produce the sound and so are soon quenched; the latter not having that drain upon them, last longer. E. H. B.

1529. *Transmission of Sound through Porous and Non-porous Materials.* **C. S. McGinnis** and **M. R. Harkins.** (Phys. Rev. 33. pp. 128–136, Aug., 1911.)—In this experimental research the source of sound was an open organ-pipe of 768 vibrations per sec., the detector being a crystal rectifier. The electrical arrangements consisted of two circuits. The first contained in series, a telephone receiver (in the path of the stationary sound-waves), a capacity and the primary of a transformer. The second circuit included the secondary of the transformer, a resistance, a sensitive moving-coil galvanometer, and the crystal rectifier. The results may be summarised as follows: (1) The crystal rectifier is reliable for comparisons of sound-intensities, but not for absolute determinations. (2) For non-porous substances, or those nearly so, the intensity of sound transmitted is either zero or considerably less than 1 per cent. (3) For porous substances of woven texture the general law for the transmission is the exponential one, *i.e.*, each sheet transmits a definite percentage of the sound incident upon it. (4) Most of the sound which is commonly said to be transmitted is due to the lateral vibrations of the material as an independent sound-source. The intensity actually transmitted depends upon the size and nature of the pores, *i.e.*, absorption is the predominating factor. This is in agreement with the general idea of Tufts, viz., that the transmission of sound depends definitely upon the facility with which the substance transmits currents of air. [See Abstracts Nos. 1664 (1901) and 109 (1911).] E. H. B.

1530. *Musical Echoes.* **F. R. Watson.** (Science, 34. pp. 454–455, Oct. 6, 1911.)—The Greek Theatre at the University of California presents a pronounced musical echo, the conditions being especially favourable to the production of the phenomenon. The seats are made up of a series of large concrete steps that are semicircular in shape and that rise regularly towards the back. If an observer generates a sharp sound in front of the stage at the centre of the circles of steps, the sound passes out symmetrically and strikes the steps in perpendicular planes and is reflected and diffracted back to the source of sound. The pulses of sound reflected from the successive steps follow each other regularly and thus set up a musical sound which is heard by the observer. It occurred to the author that the pitch of the sound might be determined by comparison with an adjustable Koenig fork and compared with the theoretical value deducible from the width of the steps (76 cm.) and the temperature at the time (22° C.). The experimental value found was 226 per sec. and the calculated value 227, the agreement being closer than might have been expected. Another example of a musical echo is cited in which the experimental estimates of the frequency varied between 235 and 241 per sec., that calculated being 236. E. H. B.

1531. *Church Bells.* **P. J. Blessing.** (Phys. Zeitschr. 12. pp. 597–600, July 15, 1911.)—A discussion of the various characteristics of the sounds of bells of which as yet no sufficient explanation has been given. Thus, it is asked: (1) Why is one simple tone (called the nominal) so much more prominent at first than all the rest? (2) Why is there another tone with approximately the octave relation with this?—and so forth. The wish is expressed that some clue to these enigmas may yet be found. E. H. B.

REFERENCES.

1532. *Singing Flame Chronograph.* **L. Benoist.** (Comptes Rendus, 153. pp. 96–97, July 10, 1911.)—Describes the arrangement of an acetylene lamp with very fine flame, about 2 cm. high, and cylindrical chimney to form a singing flame which, with a rotating mirror and photographic apparatus, constitutes an acoustical chronophotograph. E. H. B.

1533. *Vibrations of Elliptical Membranes.* **E. Reinstein.** (Ann. d. Physik, 35. 1. pp. 109–144, June 2, 1911.)—For uniformly stretched membranes with fixed elliptic boundary the differential equation is written in terms of elliptic co-ordinates. It is then solved and a number of cases are numerically calculated and the nodal lines plotted. These are usually confocal hyperbolæ and ellipses and are illustrated in 32 diagrams and 12 photographs. E. H. B.

1534. *Sonorous Pipes.* **Melchissédec** and **Frossard.** (Comptes Rendus, 153. pp. 176–179, July 17, 1911.)—Discusses the action of such combinations of reeds, tubes, &c., as are presented by the human larynx, mouth, and nose. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1535. *Path of an Electron in Radial Fields.* **H. S. Allen.** (Roy. Soc., Proc. Ser. A. 85. pp. 257–262, June 9, 1911.)—The fluorescence on the walls was studied in a focus tube in which the anti-kathode was a magnetic pole. The path of an electron in a radial field was investigated mathematically, and was found to lie on a right circular cone whose vertex coincides with the magnetic pole. If the surface of the cone is developed into a plane the trace of the path is a conic section, with the vertex as focus. This result continues to hold when an electric field [see Abstract No. 659 (1911)], with its lines of force radiating from the same point, is superposed on the magnetic field. The magnet used in the experiments was an electromagnet with its pole in the centre of the focus tube, opposite the concave kathode. In the absence of a magnetic field, a ring of green fluorescence encircled the shadow of the bar magnet. On exciting the magnet this ring moved along the wall towards the kathode, and as the magnetic field became stronger, it moved close up to the kathode. Simultaneously, a cone of violet light appeared within the ring, with its vertex at the magnetic pole. The boundary of this cone is the envelope of all the cones on which the spiral paths of the electrons lie. E. E. F.

1536. *Emission and Absorption of Energy by Electrons.* **S. B. McLaren.** (Phil. Mag. 22. pp. 66–83, July, 1911.)—Lorentz's theory of complete radiation is here extended to all wave-lengths. The negative electrons, moving in any conservative field of force due to the positive charges, absorb energy from the external radiation and by their motion return energy to it. Their velocities need not be small compared with the velocity of light; the pressure of radiation, the Doppler-effect, and the change of mass are all allowed for. In the present paper, however, the negative electrons are not supposed to influence each other and the positive charges remain at rest, as in Lorentz's own work. It is hoped to prove elsewhere that these restrictions can be removed without altering the character of the results. Here, too, the radiation is simply assumed as an external field in addition to the other forces. The author also hopes to show how the radiation may be defined as distinguished from the forces of interaction of the charges, positive or negative, at any internal point of a hot body. The formal mathematical treatment then commences and deals in succession with the following topics: Disturbed motion due to radiation, Significance of Wien's law, Disturbed orbits, Absorption of radiation, Emission of radiation, Complete radiation.

E. H. B.

1537. *Law of Biot and Savart.* **R. Gans.** (Phys. Zeitschr. 12. pp. 806–811, Oct. 1, 1911.)—Recently doubts have arisen as to whether the law of Biot and Savart held if the conductor in question were magnetisable. The present paper is a mathematical investigation of the point from which the author concludes that for ferromagnetic bodies also the theorem still holds that the Biot-Savart force is independent of the material of the conductor. [See Abstract No. 1996 (1908).] E. H. B.

1538. *Capacity Coefficients of Spherical Electrodes.* **A. Russell.** (Phys. Soc., Proc. 23. pp. 352–360; Discussion, p. 360, Aug., 1911.)—Formulæ have been given by Poisson, Kelvin, Kirchhoff, Clerk Maxwell and others for the capacity coefficients of spherical conductors at appreciable distances apart. With the exception of Kirchhoff's formulæ, these formulæ are rarely, if ever, used in practice. The author shows how the remainder after computing a few terms of Kirchhoff's series formulæ can easily be found. The range of their usefulness is therefore considerably extended. This extension makes it possible to simplify very appreciably the author's formulæ for the case, when the spheres are close together. Hence he shows that the numerical computation of the capacity coefficients can easily be made in all cases. Applications showing how the potentials, the capacities and the capacity currents of spherical electrodes can be calculated are given. A simple method of making a variable air condenser whose capacity in every position can readily be calculated to any desired accuracy is also given. A. R.

1539. *Electrical Conductivity of the Air.* **R. Ichinohe, M. Kinoshita,** and **M. Kimura.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 155–169, July, 1911.)—The observation of the specific electrical conductivity of the air was carried on by the authors during May 19–24, 1910, in a small building situated on Yoshida Hill, about 100 m. high. Gerdien's apparatus was used, and the specific conductivity of air calculated from Gerdien's formulæ. The results are tabulated and graphs obtained, the weather conditions being given. These show a greater conductivity for positive electricity, the mean ratio λ_p/λ_n being 1·08. The curves showing the daily variations of conductivity for positive and negative electricity are almost parallel, there being two maxima and two minima. The conductivity was above the average during the night and early morning, and below the average during the day and evening. From curves showing the daily variations of humidity, temperature, and barometric pressure it is seen that the conductivity variations are closely related to variations of these quantities, the conductivity variations lagging behind variations of the other quantities. A. W.

DISCHARGE AND OSCILLATIONS.

1540. *Dissymmetry of Positive and Negative Ions relative to the Condensation of Water-vapour.* **E. Besson.** (Comptes Rendus, 153. pp. 250–253, July 24, 1911.)—The difference in behaviour of positive and negative ions relative to the condensation of water-vapour was first pointed out by C. T. R. Wilson, who observed a greater or smaller intensity of cloud produced by an expansion greater than the critical expansion 1·25, under the action of a very weak electric field. By his method the comparison between the clouds was made with the eye, and this observation is often very difficult; on this account, the phenomena are now studied by the aid of photography. A modified form of Wilson's apparatus is used. In the very great majority of cases the dissymmetry pointed out by Wilson in respect to the greater facility of condensation of water-vapour on negative ions, which is not obvious to the naked eye, has been put in evidence in a very clear manner by the photographs obtained. A. E. G.

1541. *The Charges on Ions in Gases.* **J. S. Townsend.** (Roy. Soc., Proc. Ser. A. 85. pp. 25–29, March 14, 1911.)—A stream of ions produced by secondary Röntgen rays in gases was allowed to pass through a circular hole in a plate. The ions were received, after passing through an electric field for a certain distance, on (1) a flat disc, and (2) a flat ring surrounding the disc. The ratio of the quantities of ions in the two cases is found. The ratio should be independent of the pressure if the ions follow the laws of diffusion. This is confirmed for hydrogen, oxygen, and CO_2. The value of N*e* for negative ions under a variety of circumstances is always the same as in electrolysis of liquids, namely, $1{\cdot}22 \times 10^{10}$. This is also true for the positive ions when the secondary X-rays originate at a bright metallic surface, but high values are obtained when the surface is coated with vaseline, showing that some of the ions produced by the more penetrating rays carry double charges. In perfectly dry gases at low pressure the above ratio is no longer independent of pressure, but the determinations of N*e* may be made with higher pressures and low electric force. The negative ions assume the corpuscular state in dry gases at low pressure. The mass of the ion can be calculated from its diffusion coefficient. In ordinary circumstances the mass of the negative ion in air is 11 times the mass of the molecule of CO_2. When X is 0·9 volt per cm., and the pressure is 10 mm., the mass of the negative ion in perfectly dried air is only $\frac{1}{42}$ of the mass of the molecule of CO_2.

L. H. W

1542. *Mass o, Gaseous Ions.* **W. Duane.** (Comptes Rendus, 153. pp. 336–339, July 31, 1911.)—The paper deals mainly with the ratio of the mass to the charge of the positive ions formed in air or hydrogen at low pressure ionised by α-rays. A narrow intense pencil of α-rays was caused to produce a layer of ions midway between two electrodes enclosed in a box at low pressure. The upper electrode was connected to an electrometer and the lower one to a high-potential battery, while the whole vessel was placed between the poles of an electromagnet so as to give a magnetic field parallel to the electrodes and perpendicular to the pencil of α-particles. The paths of the ions produced will thus be cycloids, and the max. distance which they traverse towards the plates will depend on the magnitudes of the electric and magnetic fields; and keeping the electric field constant a sufficiently strong magnetic field will prevent any ions reaching the electrode connected to the electrometer. From the observations the value of m/e can be deduced, provided the pressure is so low that the mean free path of the ions is large and the electric field used great enough to make their velocity due to it large compared with their velocities at the moment of formation. The results show that in air at low pressures the negative ions consist entirely of electrons and the positive ions of molecules of N and O charged with one or two elementary charges. The ionisation current due to positive ions was not entirely suppressed by large magnetic fields, indicating either that the mean free path was not large enough or that there exist still larger ions. The experiments also indicate that very few, if any, of the positive ions in air are of the same mass as the hydrogen atom.

E. M.

1543. *Radio-active Ions.* **J. Franck and L. Meitner.** (Deutsch. Phys. Gesell., Verh. 13. 17. pp. 671–675, Sept. 15, 1911.)—The principle of the method adopted in these experiments is that of driving the ions by means of an electric field against a current of air. Two wire nets placed in a specially constructed tube can be arranged at any required distance apart and raised to any potential. The wire net forming the anode is made the source of radio-active ions by subjecting it to the action of radio-thorium. As the result of the experiments described it is concluded that the mobility of the positive radio-active rest-atom is, within the limit of experimental error, the same as that of ions of the surrounding gas, and that the rest-atoms move like normal ions and always retain their charge. The hypothesis of Wellisch [see Abstract No. 647 (1911)], which requires that radio-active ions are sometimes in a charged, and at others in an uncharged condition, is apparently in opposition to these results. It also appears that Wellisch's theory of the mobility of ions is at fault, since according to that theory a much smaller velocity in electric fields than is now found is to be expected for radio-active ions which continually retain their charge. A. E. G.

1544. *Method of making Visible the Paths of Ionising Particles.* **C. T. R. Wilson.** (Roy. Soc., Proc. Ser. A. 85. pp. 285–288, June 9, 1911.)—The author has succeeded in photographing the tracks of individual α- and β-rays by condensation on the ions produced by them. A cylindrical cloud chamber was used, with flat horizontal roof and floor, of diam. 7·5 cm., and height 4 mm. before expansion and 6·2 cm. after expansion. The expansion was effected by a sudden downward displacement of the floor, and the resulting clouds were viewed through the roof. A p.d. of 8 volts was applied between the roof and the floor, so that the only ions caught and viewed on expansion were those which had been produced within less than $\frac{1}{10}$ sec. before the expansion and those which were set free in the short interval after the expansion, during which the supersaturation exceeded the limit necessary for condensation on the ions. The results were as follows: (1) With large expansions in absence of ions a uniform distribution of drops was observed. (2) When an α-ray source was used inside the chamber, on expansion the drops followed and showed the tracks of the α-particles, and could be photographed by means of a spark arrangement. (3) When a source of β-rays was placed near a thin Al window of the cloud chamber, thread-like lines of cloud were produced, radiating from the window, while the tracks of secondary β-rays from the walls of the chamber could also be traced. (4) When γ-rays were allowed to fall on the vessel the cloud was localised in streaks, due to the secondary β-rays from the walls. (5) With a beam of X-rays the region traversed by the primary beam was seen to be filled with minute streaks and patches of cloud, a few due to secondary X-rays appearing also outside the primary beam. The cloudlets showed on the photographs (reproduced in the paper) as small thread-like objects not more than a few mm. in length, and less than $\frac{1}{10}$ mm. in breadth. This latter result is in agreement with Bragg's view that the whole of the ionisation produced by X-rays may be regarded as being due to β- or kathode-rays arising from the X-rays. E. M.

1545. *Magnetic Rays.* **A. Righi.** (Accad. Lincei, Atti, 20. pp. 163–167, Aug. 20, 1911. Phys. Zeitschr. 12. pp. 835–837, Oct. 15, 1911.)—Describes two new experiments on magnetic or "magneto-kathodic" rays. A discharge is led through a flat coil. A spherical exhausted glass vessel, of diameter somewhat greater than the internal diam. of the coil, is partly inserted in the latter. The other side of the vessel abuts against a magnetic pole. A ring of light is seen within the vessel, co-axial with the coil, and lying nearly in its plane. From this ring, as soon as the magnet is excited, rays proceed towards the pole, and practically trace out the magnetic lines of force. They form a kind of trumpet, the narrow end of which contracts as the magnetic field is strengthened. The other arrangement consists of a canal-ray tube, in which the generating tube can be inserted in the core of an electromagnet. The "canal" is bored through the kathode in a slanting direction. As soon as the magnet is excited a bundle of new rays appears in the direction of the lines of force. This bundle is magnetically deviable. When the "canal" is axial it is found that the positive charge of the canal rays becomes more and more feeble as the electromagnet becomes stronger. This the author attributes to the formation of doublets constituting molecular magnets or magnetic rays. [See Abstract No. 1084 (1909).] E. E. F.

1546. *Influence of Magnetic Field on a Current in a Vacuum Tube.* **A. Righi.** (Accad. Lincei, Atti, 20. pp. 167–170, Aug. 20, 1911. Phys. Zeitschr. 12. pp. 833–835, Oct. 15, 1911.)—The interpretation of "secondary kathode rays" as magnetic rays, or rays consisting of atom-electron doublets, is confirmed by the behaviour of the current and potential in a vacuum tube when the magnetic field is gradually increased. The substitution of doublets for kathode rays necessarily reduces the current and increases the p.d. The author finds this to be the case. He used 2000 small accumulators, and an electromagnetic giving a field of 2500 gauss. The p.d. increased suddenly at 600 gauss, and went on increasing till 1100 gauss (about 1900 volts). Then it fell abruptly to 1700 volts, after which it slowly increased. Simultaneously the current fell from 0·8 milliamp. to 0·6 milliamp., and rose again to a steady value of 0·67 milliamp. The region marked by high potential and low current is the interval in which magnetic rays are formed. E. E. F.

1547. *Canal and Kathode Rays.* **R. Ichinohe.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 193–195, July, 1911.)—The aim of this research is to find the relations existing between the form of the kathode and the corresponding canal and kathode rays. The discharge tube used in the experiments is a large spherical glass bulb 10·5 cm. in diam. The kathode, which consists of two parallel plates or bent wires of different shapes, is placed in the centre of the bulb. The results obtained are shown in a series of drawings, which give the plan and elevation of the kathode and the plan and elevation of the canal rays and phosphorescence of the glass bulb, due to the kathode rays corresponding to the different-shaped kathodes. A. E. G.

1548. *Mean Free Path in Canal Rays.* **W. Wien.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 38. pp. 773–786, 1911.)—Experiments were made at various pressures of hydrogen, and from the observations values of the mean free paths under the standard pressure of 760 mm. of Hg were deduced. Thus, from experiments at pressures from 0·004 to 0·006 the mean free path was calculated to be $6{\cdot}15 \times 10^{-6}$ cm. With higher pressures, from 0·02 to 0·04, the value $18{\cdot}8 \times 10^{-6}$ cm. was obtained for the path at 1 atmo. [See Abstract No. 765 (1911).] E. H. B.

1549. *Path of Kathode Rays emitted by a Wehnelt Kathode in a Homogeneous Magnetic Field.* **A. Bestelmeyer.** (Ann. d. Physik, 35. 5. pp. 909–930, Sept. 1, 1911.)—In these experiments a new determination is made of the value of *e/m* for kathode rays, by observing the discharge potential and the magnetic deviation. The results obtained by Classen and by Lerp [Abstracts Nos. 118 (1909) and 504 (1911)] are confirmed. The purpose of the present work is rather to establish the method of measurement and calculation employed than to carry the determination to the highest possible exactitude. A. E. G.

1550. *Photo-electric Effect and Wave-length of Röntgen Rays.* **J. Kunz.** (Phys. Rev. 33. pp. 208–214, Sept., 1911.)—At the red end of the spectrum the positive potential acquired by the alkali metals under radiation depends on the intensity of the light, whereas at the blue end it depends more upon the frequency, and is, indeed, proportional to the square of the frequency. If this holds throughout the ultra-violet region it gives an exact means of measuring the thickness of the pulse or the wave-length equivalent of Röntgen rays, γ-rays, or secondary Röntgen radiation. In experiments made to test this relation the light was derived from those lines in the spectra of Cd, Zn, and Cu which produce phosphorescence on the willemite screen. Cs, Rb, and K-Na surfaces were used. The relation was found to hold good for all the ultra-violet lines examined. It was therefore extrapolated to find the wave-length equivalent of Röntgen rays, which came out as 2·65 $\mu\mu$, a rather large value as compared with other determinations. It should be inversely proportional to the p.d. between kathode and anode, and this is susceptible of an experimental verification. E. E. F.

1551. *Reliability of Measurements with Sounds in the Kathode Dark Space.* **A. Wehnelt.** (Deutsch. Phys. Gesell., Verh. 13. 14. pp. 505–510, July 30, 1911.)—To study the effect produced by the introduction of "sounds," obstructions in the form of a glass rod or a small disc of Pt are placed in the kathode dark space, and the resulting distribution of potential measured. For the latter purpose sounds are used, since, although such procedure is not free from error, certain conclusions can be drawn from the measurements made. From the form of the potential curve given it appears that there is the greatest quantity of free positive electricity at the obstruction. Between the kathode and the obstruction the rise in the potential curve is a perfectly straight line, and there is no free charge present. Between the glow-light and the obstruction the curve is slightly bent. From the given d^2V/dx^2-curve it appears that every sound placed in the kathode dark space behaves in a similar manner to the obstructions here used, and that they are consequently charged to a higher positive potential than corresponds to their position. From these results it follows that all measurements made with sounds in the kathode dark space are subject to error, and therefore open to objection. [**Erratum,** Ibid. 13. 17. p. 693, Sept. 15, 1911.] A. E. G.

1552. *Intensity of Ultra-violet Light emitted by an Electrical Discharge at Low Pressures.* **E. W. B. Gill.** (Phil. Mag. 22. pp. 412–418, Sept., 1911.)—When ultra-violet light falls upon a zinc plate negative ions are set free at its surface, and other things being equal, the number of ions set free is nearly proportional to the intensity of the light. An estimate of the number of ions set free by the light coming from different portions of the tube will therefore give at once the relative intensities. The discharge tube, having electrodes 7·5 cm. apart, is constructed of quartz, and is contained in a lead box having a vertical slit (1 cm. wide) cut in the side; and the tube is so mounted that any portion of its length can be placed in front of this slit. The light emerging from the slit passes through wire gauze and falls upon a zinc plate connected to an electrometer, the distance between the plate and the gauze being about 1 cm. The wire gauze is charged to +40 volts, and the zinc plate is initially at zero potential and insulated. The relative intensities of each cm. of the tube are obtained by observing the deflections of the electrometer. The results are shown diagramatically, and it is evident that for the range of pressures considered the emission of ultra-violet light from the ½ cm., beginning at the kathode, is practically negligible. The kathode fall of potential does not extend beyond this space, and the results therefore confirm the theory that practically all the energy in this space is devoted to forming fresh ions by collision, and very little of the energy is available for emitting radiations. For pressures above that corresponding to the minimum sparking potential, the greater part of the light comes from the end of the tube nearer the anode, the amount from the centre being small. At pressures below that corresponding to minimum sparking potential it appears that the character of the discharge is radically changed. A. E. G.

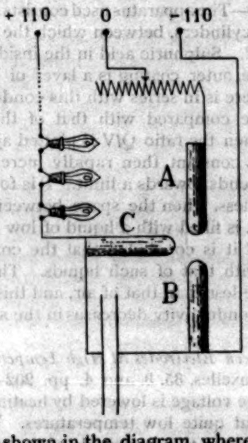
1553. *"Dark" Sparks.* **P. Metzner.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 612–616, Aug. 15, 1911.)—Describes cases of electrical discharge in which parts are dark but with a fine bright line running through the centre. In some cases where a photograph shows a dark region, this really corresponds to the brightest portion of the discharge. E. H. B.

1554. *Conductivity of Gas at Atmospheric Pressure under the Influence of a High Alternating Voltage.* **A. Chassy.** (Journ. de Physique, 1. Ser. 5. pp. 737–744, Sept., 1911.)—The apparatus used consists of a condenser composed of two concentric glass cylinders, between which the gas whose conductivity is being tested, is placed. Sulphuric acid in the inside cylinder serves as the inner coating, while the outer coating is a layer of tin-foil on the outside of the larger cylinder. There is in series with this condenser another condenser whose capacity is large compared with that of the former. In the curve given it is seen that when the ratio Q/V is plotted against V, as V increases, the ratio at first remains constant, then rapidly increases, and finally, after a more gradual increase, tends towards a limit. It is found that the capacity of the condenser is much less, when the space between the cylinders is filled with a gas than when it is filled with a liquid of low conducting power such as water or alcohol, and it is concluded that the conductivity of the gas is very small compared with that of such liquids. The dielectric cohesion of hydrogen is found to be less than that of air, and this again less than that of ozonised air, while the conductivity decreases in the same order. A. E. G.

1555. *Discharge between Electrodes at High Temperatures.* **De Muynck.** (Annal. Soc. Sci. de Bruxelles, 35. 3. and 4. pp. 202–212, 1910–1911.)—It is proved that the disruptive voltage is lowered by heating one of the electrodes. This effect is obtained at quite low temperatures. Within the limits of the accuracy of the experiments the magnitude of the effect does not vary with the polarity of the electrode which is heated. To find the cause of these phenomena further experiments are required. A. R.

1556. *New Method of determining the Potential Gradient in the Glow and Arc Discharge in Cylindrical Glass and Quartz Tubes.* **W. Matthies.** (Deutsch. Phys. Gesell., Verh. 13. 14. pp. 552–568, July 30, 1911.)—This method rests upon the known phenomenon that glass at about 150° C., and some quartz glasses at about 270° C. become a weak conductor of electricity. Cylindrical glass or quartz tubes of such dimensions that the current passed through raises the temperature of the tube walls to at least 150° C. or 270° C. are therefore used. Under these conditions the walls of the vessel at any particular spot must necessarily be raised to the same potential as that of the contained gas. Kathode and anode are arranged so that equi-potential surfaces are planes at right angles to the axis of the tube. A system of fine parallel metal rings are placed round the outside of the tube, the planes of the rings being at right angles to the direction of the current. From the measurements of the distances between these rings and the p.d. between them it then becomes possible to calculate the mean potential gradient in that portion of the tube. By measurements carried out with mercury arcs and glow discharge in tubes with Wehnelt kathode, it is shown that the mean potential gradient as found by means of "sounds" and rings are in complete agreement within the limits of experimental error. A. E. G.

1557. *Low-potential Sparks.* **A. Occhialini.** (N. Cimento, 2. Ser. 6. pp. 223–228, Sept., 1911.)—In its initial stages, the electric arc behaves with respect to a magnetic field like a spark, and shows a line spectrum instead of a band spectrum. When a suitable capacity is put in parallel with the arc the latter shows in its initial stages the high-excitation lines seen with a spark and condenser. The arc lines not contained in the spark spectrum only appear when the arc is fully lighted. The arrangement adopted for obtaining these low-potential sparks is shown in the diagram, where the electrodes A and B are of carbon and are connected with the negative and neutral wires respectively of a three-wire system, whereas C is metallic and is positive. A capacity is inserted between B and C. An auxiliary arc is lighted between A and B. The arc between B and C is kept in its initial stages by inserting a high resistance between C and the positive main. At a suitable distance it becomes a singing discharge, but this can be rendered silent by introducing an inductance in the condenser arm. E. E. F.



1558. *Ultra-violet Radiation from Quartz Mercury Lamp.* **V. Henri.** (Comptes Rendus, 153. pp. 265–267, July 24, 1911.)—Gives the results of an investigation of the ultra-violet radiation by a series of photochemical reactions. The following reactions were chosen: (1) Dissociation of pure and dry HCl; this reaction is produced exclusively by the extreme ultra-violet rays of wave-length λ < 2800. (2) Decomposition of oxygenated water; this reaction takes place 10 times more slowly when a screen of white glass of 1 mm. thickness is placed in front of the lamp. (3) Appearance of acids in a solution of saccharose. The concentration of H-ions is measured by the electrometric method using a hydrogen electrode. A glass screen retards this reaction 15 to 20 times. (4) Decomposition of KI in presence of sulphuric acid. A glass screen retards this reaction 4 to 5 times. (5) Action on paper treated with citrate of silver. A glass screen retards the action 8 times. (6) Action on an emulsion of coli bacillus; 100 c.cm. of emulsion are placed in a porcelain crucible 6 cm. diam., the bottom of the crucible being 20 cm. from the lamp. A glass screen increases the duration of sterilisation from 1000 to 2000 times. In addition, spectrophotometric measurements of intensity were made in the five regions of the visible spectrum: red $\lambda = 6123$ and 6073, yellow $\lambda = 5790$ and 5769, green $\lambda = 5460$, blue $\lambda = 4358$, and violet $\lambda = 4046$. Tables are given showing the variation in the effects due to increase in the energy consumption of the lamp. Results are only given for tests Nos. 4, 5 and 6 and for the spectrophotometric determinations. The tables show (1) The ultra-violet radiation of the lamp increases very quickly with the energy consumption. This increase is particularly rapid above 200 watts. Thus a 110-volt lamp taking 52·9 watts only sterilises in 800 sec. what the same lamp taking 815 watts does in 8 sec. Similarly a 220-volt lamp at 96·2 watts takes 60 sec., against 1 sec. at 658 watts. (2) The action on citrate of silver is absolutely parallel to the bactericidal action of the rays emitted by a lamp; hence, in applications to sterilisation, the action of the lamp can be controlled by means of this reaction. (3) The reaction on KI increases more slowly than that on citrate of silver and on the emulsion. (4) The intensity of the yellow rays 5790 and 5769 increases much more quickly than that of the green and blue rays (a result already obtained by Küch and Retschinsky and by Pflüger); the activity of the rays of the lamp on the citrate and on the emulsion increases almost as quickly as the intensity of the yellow rays, which shows that the extreme ultra-violet radiation increases much quicker than the total visible radiation of the lamp. A. W.

1559. *Ultra-violet Radiation from Quartz Mercury Lamp.* **V. Henri.** (Comptes Rendus, 153. pp. 426–429, Aug. 14, 1911.)—It is important to know how the ultra-violet radiation from the quartz mercury lamp varies, for different cooling conditions, when the electric condition of the lamp is varied. For this purpose the author used the citrate of silver method [see preceding Abstract]. The experiments were made with a new lamp of the Westinghouse Cooper Hewitt type, the luminous tube being 60 mm. long, and the condensation bulb above the + pole 45 mm. in diam. The lamp was used in four different conditions, and it is shown that the ultra-violet radiation of the lamp is the more intense the higher the temperature of the luminous tube. In particular, if the tube is water-cooled the ultra-violet radiation is 14 times weaker than is the case where the lamp is in the open air and consuming the same number of watts. The power of radiating ultra-violet light seems to depend not on the number of watts consumed, but on the fall of potential in the luminous tube. A second important point from a practical standpoint is the life and the constancy of the lamps. Bordier, Courmont, and Nogier have found that quartz mercury lamps lose their power of giving ultra-violet radiation; Buisson and Fabry, on the other hand, found that a lamp after 600 hours possessed an ultra-violet radiation almost as intense as another new lamp. The author has compared six different quartz lamps which have been used for different lengths of time up to 8 years. There are differences in the electric conditions, probably due to the degree of vacuum or to slight differences in the dimensions, and the ultra-violet activity varies from lamp to lamp, but the older lamps show no decrease of activity—in fact, some are richer in ultra-violet radiation than the new lamp used. Hence for a given voltage, current, and length of tube, it seems probable that the ultra-violet radiation from a quartz mercury lamp is sensibly constant. A. W.

1560. *Luminescence of Mercury Arc in Vacuum.* **A. Perot.** (Journ. de Physique, 1. Ser. 5. pp. 609–626, Aug., 1911. Paper read before the Soc. franç. de Physique, Dec. 2, 1910.)—Describes research on the production of the light in the vacuum mercury arc. The observations were made on the principal component (C) of the green line 5461 Å., and on the bright satellite (S) whose wave-length is a little greater than that of the principal component. An étalon was used, the light first passing through absorbing plates and being then focussed on a 6-mm. hole in a screen close to the étalon. The complex system of rings was observed by means of a micrometer eyepiece, and the rings due to C and S were easily discerned. The dispersion of the étalon was such that a relative variation of wave-length of the satellite S of magnitude 5×10^{-8} could be measured. Continuous current was employed for the arc. Among other forms of tube one was of the ordinary H-form; another had one of the upper limbs of the H suppressed. Looking in a direction normal to the axis of the horizontal tube, the rings due to the rays C and S are alone seen, accompanied by those of the more feeble satellites. This is true, for the tubes used, although the current was varied from 2 to 4·5 amps./cm.². Looking in the direction of the horizontal tube, either from the anode or kathode side, the ray S keeps the same appearance for variations of current intensity and of pressure; its brightness and size alone vary. The ray C, as the pressure rises, shows a black line, very fine and well marked, in the middle region of the bright ring, corresponding to a doubling. The black line broadens as the pressure rises, but asymmetrically. For a pressure of 25 to 30 mm. the rays S, C′, C″ seem to be about equidistant and of almost the same intensity. Finally, if the pressure is still further raised, the part C″ of the line C, situated towards the red, disappears almost completely, leaving the two lines C′ and S. The two rays C and S appear then to be of different kinds. This result can explain the variations with wave-length of the absorbing power of a mercury arc on another arc, as observed by Kuch and Retschinsky. The luminosity of the arc was studied in special tubes of spherical form with attached side-tubes for the electrodes. Interesting points dealt with in the paper are (i) The aspect of the discharge as the pressure is varied, (ii) Electric transport of mercury, (iii) Action of water vapour, (iv) Velocity of the luminous centres, (v) Distribution of potential in the arc, (vi) Pressure excess at the anode. The following conclusions are deduced: (1) The emission of spectral rays by the corpuscular carriers of electricity is extremely feeble, if not nil. (2) This emission is due to mercury atoms put in luminescent vibration by the electric carriers. (3) These luminous centres encounter in their motion inert molecules which they put in motion without rendering them luminous. (4) The fall of potential along the arc has the effect of restoring the velocity of the carriers at each instant to its initial value, in spite of the retarding blows they receive. (5) The energy of the luminous centres consists of two parts, the energy of translation and that of radiation; this latter is probably not altered by the blows, whose sole effect would be to produce a difference of phase in the vibratory movement emitted. The latter part of the paper deals theoretically with the subject. A. W.

1561. *Effect of Electric Waves on Platinum Mirrors.* **J. Clay.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 126–128, Aug. 28, 1911.)—Electric waves falling on a Pt mirror at large distances from the source of the waves, cause a decrease of the resistance of the mirror; at short distances, an increase. The effect is mechanical, as is shown by the fact that the firmer the Pt layer the less the effect. T. P. B.

1562. *Skin Effect in Linear Conductors of Rectangular Cross-Section.* **H. W. Edwards.** (Phys. Rev. 33. pp. 184–202, Sept., 1911.)—High-freqnency alternating currents, which could easily be measured, were obtained by discharging a condenser through an inductive resistance. A suitable ammeter for their measurement is described and Fleming's method, slightly modified, of a photographic spark-counter was employed. It is shown that the effects of the damping of the oscillating currents could be neglected. The ratio of the effective to the direct-current resistance for copper wires of square and rectangular cross-section was measured by means of a differential thermometer, and these observed values were checked by approximate formulæ for frequencies up to about 200,000 per sec. Various useful formulæ are given, both for the resistance of rectangular wires and for the current intensity over their cross-section at high frequencies. The value of the current intensity over the cross-section in various cases is computed and diagrams are given to illustrate the results. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1563. *Theory of Action of Selenium.* **F. C. Brown.** (Phys. Rev. 33. pp. 1–26, July, 1911.)—The author advocates a chemical rather than an electronic theory of the light action of selenium. He postulates that light produces two changes of opposite sign in the conductivity of all light-sensitive varieties of Se. The amount of the change is a function of the time of illumination as well as of the intensity and character of the illumination. In a Giltay cell examined, the selenium shows the same two changes under the action of high p.d.'s that it shows under the action of light. The character of the conductivity curves for the four known varieties of light-sensitive Se can be explained by assuming the existence of three components, A, B, and C, in dynamic equilibrium under given illumination, temperature. pressure, and p.d. Any agency which affects the conductivity of Se does so by altering the rate of interchange between the components. The experimental results can be explained to a first order of approximation on the assumption that only the B kind is conducting. If the conductivity changes only when the amount of the B kind is changed, the failure of Ohm's law is only apparent, and not real. E. E. F.

1564. *Report of British Association Electrical Standards Committee.* (Electrician, 67. p. 895, Sept. 15, 1911.)—The progress made with the Lorenz apparatus and the construction of international electrical standards is briefly described. To eliminate the effect of variable humidity on the resistance of shallacked coils, many of the latter have been hermetically sealed and are now much more constant than previous to the sealing. Figures are given showing the changes in resistance of 4 coils. Before sealing the changes in 5 years were respectively 33, 15, 112, and 36 parts in 100,000; after sealing the corresponding changes in 2 years were 3, 1, 2, and 1 part in 100,000. The attention of instrument-makers is drawn to the matter. F. E. S.

1565. *Temperature Coefficients of Electrical Resistance.* **A. A. Somerville.** (Phys. Rev. 33. pp. 77–80, July, 1911.)—In this paper the curves of resistance are given for tin, zinc, silicon, and various alloys. In the case of tin and zinc the resistance increases very rapidly as the metals melt. Silicon shows a negative coefficient from 0° to 210°; then a positive coefficient to 420°; thereafter a negative coefficient. [See Abstracts Nos. 1326 and 1758 (1910).] T. P. B.

1566. *Measurement of Fluctuations in a Rapidly Varying Resistance.* **F. C. Brown** and **W. H. Clark.** (Phys. Rev. 33. pp. 58–59, July, 1911.)—The varying resistance is connected up in one of the arms of a Wheatstone bridge. The difference between its average value for any short interval of time and the value which would give exact balance is then deduced from the "kick" of a ballistic galvanometer which is thrown into the circuit by means of a pendulum for the desired interval of time. The interval must be small compared to the period of the galvanometer, and its desired smallness will, of course, also depend on the rapidity with which the resistance changes. If the time is made sufficiently short the average resistance practically becomes the actual resistance at the middle of the interval. The paper gives the theory of the method and practical details of its application to the measurement of both small and large changes of resistance. A. D. R.

1567. *Electrical Conductivity of Sea-water.* **H. Schmidt.** (Jahrbuch d. Drahtlosen Telegraphie, 4. pp. 636–638, June, 1911.)—The conductivity of the water of the North Sea is determined by the Wheatstone bridge method with alternating current and telephone. The mean value at 20° C. is 0·0397 ohm^{-1} cm.$^{-1}$. At the place in which the experiments are made the value of the conductivity depends very little on the distance from the shore at which the water is taken, and also very little on the weather. No change is observed in the conductivity when the water is kept standing for some days after being taken from the sea. T. P. B.

1568. *Electrical Conductivity of Sea and Land.* **K. Uller.** (Jahrbuch d. Drahtlosen Telegraphie, 4. pp. 638–640, June, 1911.)—The values of the conductivity which have been found for sea-water and for land are collected and compared. The conductivity of sea-water naturally depends upon the amount of salt in solution. For the same salt concentration and the same temperature, the conductivity of the Mediterranean is about 1¼ times that of the North Sea. The conductivity of moist earth varies from 10^{-4} to 10^{-5} ohm^{-1} cm.$^{-1}$, and that of dry earth is about 10^{-6} ohm^{-1} cm.$^{-1}$. T. P. B.

1569. *Stratified Structure of Tin Ores and Crystal Detector Action.* **T. Liebisch.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 18. pp. 414–422, 1911.)—A brief account of an investigation (qualitative only) of the structural peculiarities and the optical and thermoelectric behaviour of tin ores. When used as a detector of electric oscillations it was found that if the metal electrodes were placed upon the prismatic surfaces no detector effect was obtainable, which effect was observed only when contact was made with the pyramidal surfaces. The investigation shows that this behaviour is due to the stratified structure of the tin ore crystals. The greatest detector effect is observed when both electrodes make contact with the same pyramidal surface. In the case of crystals from Selangor, only the dark core was found to be strongly negative, thermoelectrically, to Cu; and only the core was found to give the detector effect. L. H. W.

1570. *Conductivity of Liquid Dielectrics under Ultra-violet Light.* **G. Szivessy and K. Schäfer.** (Ann. d. Physik, 35. 3. pp. 511–528, July 11, 1911.)—That liquid dielectrics experienced an increased electric conductivity by the incidence upon them of various radiations is known from the researches of J. J. Thomson, P. Curie, Jaffé, and Stark and Steubing. The last named used ultra-violet light, the action of which is here further examined by the present author, whose conclusions are as follows: (1) Paraffin oil experiences an increase of its electrical conductivity by the incidence of ultra-violet light. (2) The strength of ionisation current produced by this radiation is at low pressures proportional to them, but increases slower than the pressures, and reaches a limiting saturation current. (3) The ionisation current produced by the ultra-violet radiation increased with the duration of that radiation, and reached after a certain time a maximum or final value. (4) The current strength is independent of direction. (5) The ionisation produced by ultra-violet light shows quite similar behaviour to that shown by γ-rays [see Abstracts Nos. 1642 (1908) and 1917 (1909)]. E. H. B.

1571. *Mica Condensers as Standards of Capacity.* **H. L. Curtis.** (Bureau of Standards, Bull. 6. pp. 431–488, Nov., 1910.)—Various methods for measuring capacity, with alternating and direct current, and the advantages and disadvantages of each, are discussed. For this particular investigation the series inductance method was preferred, and was used almost exclusively. There is a wide variation in the temperature-coefficient of mica condensers, and in seeking the cause of this it was observed that of 2 condensers of similar capacity the one with the larger temperature-coefficient was the thicker. In a particular case where the coefficient was 32 parts in 100,000 per 1° the condenser was placed in molten paraffin, compressed in a vice, and left until cold. The result was an increase in the capacity of over 50 per cent. and a diminution in the temperature-coefficient to 1 part in 100,000. The effects of changes of atmospheric pressure upon the capacity are very small. With silvered-mica condensers the capacity is found to depend on the applied voltage. Inspection of some sheets of silvered mica revealed flakes of silver, which were imperfectly connected to the plates of the condenser. At low voltages these play no part in the charging of the condenser, but as the voltage is increased, there will be more and more cases where the charge will cross the intervening space, thus charging the spots of silver and increasing the capacity. Mica condensers which are kept in a vacuum and maintained at constant temperature can be relied upon within a few parts in 100,000, but condensers exposed to the ordinary changes of room temperature show unaccountable variations of the capacity of 2 or 3 parts in 10,000. It is shown that, taking the measured values of the specific resistances of mica and paraffin, Maxwell's theory of a stratified dielectric does not account for the absorption actually observed in the case of a mica condenser. F. E. S.

1572. *Bronson Resistances.* **F. Hauser.** (Phys. Zeitschr. 12. pp. 785–791, Oct. 1, 1911.)—The resistances dealt with consist of two electrodes with a source of ionisation, the current being carried entirely by the ions [see Abstract No. 816 (1905)]. The author has investigated the behaviour of such resistances with different gases at different pressures, and finds that for every gas there is a certain pressure at which the resistance behaves practically like an ohmic resistance. Thus he considers the most suitable form to be a

spherical electrode with an ionising source of α-particles at the centre, and the radius of the sphere about $1\frac{1}{4}$ times the range of the α-particles used, the latter being measured in the gas employed and at atmospheric pressure.
E. M.

1573. *A Variable High Resistance of India Ink on Paper.* **F. A. Aust.** (Phys. Rev. 32. pp. 732–733, Feb., 1911. Paper read before the Amer. Physical Soc. Phys. Zeitschr. 12. pp. 732–733, Sept. 1, 1911.)—A strip of drawing paper, 3 cm. × 45 cm., is stretched between two brass plates which are fixed on to insulating blocks. A series of lines are drawn parallel to the length of the paper with Higgins' waterproof ink, the length of each successive line being gradually decreased so that their number gradually increases as we go from one end of the paper to the other. The end with the most lines is made the high-potential terminal, and is completely saturated with ink, and whilst still damp is clamped between the brass plates. The low-potential terminal is connected to a sliding contact, so that the range of resistance can be varied from 0·01 megohm to 20,000 megohms. If a heavy paper or insulating fibre is used, and well saturated with ink, a lower resistance of moderately constant value can be produced. Thus one 2 cm. × 10 cm., which had been covered five times with ink, had a resistance when dry of about a megohm, and would carry 0·4 milliamp. before getting red-hot. A similar one of asbestos paper carried 40 to 50 milliamps. without undergoing any permanent change. The temperature coefficient of resistance was from $-0·01$ to $-0·015$ per 1 deg. C.
W. C. S. P.

1574. *Large Electrostatic Machine.* **P. Villard and H. Abraham.** (Comptes Rendus, 153. pp. 1813–1814, June 26, 1911.)—A description of a Wimshurst machine having twenty ebonite plates, each of 72 cm. diam. The construction is sufficiently good for the machine to stand a speed of 1200 to 1400 revs. per min. The output at 250,000 volts is 1 milliamp.; at low voltages the max. current is 3 milliamps. The max. spark-length between spheres of 6 to 7 cm. diam. is 55 cm. The max. voltage which has been obtained is about 320,000.
W. C. S. P.

ALTERNATING CURRENTS AND MAGNETISM.

1575. *Eddy-current Losses in and Effective Resistance of Straight Circular Metal Cylinders.* **P. O. Pedersen.** (Jahrbuch d. Drahtlosen Telegraphie, 4. pp. 501–515, May, 1911.)—A mathematical paper dealing with the eddy-current losses and effective resistance of straight circular wires, placed in an harmonically varying magnetic field, of which the direction is parallel to the axis of the wire. The results are obtained by means of Kelvin's *ber-* and *bei-*functions. Tables are given, which show the values of these functions, for the range $x=0$ to $x=6$, the interval being 0·2, and also the values of the deduced functions, which are required for the calculation of eddy-current loss, effective resistance and self-induction for the same range, the interval being 0·05. Values lying within this interval can be obtained by interpolation to an accuracy of 1 per cent. Approximate formulæ are also given, which may be used for the calculation of the same functions, for $x<1$ and $x>6$, the error being not greater than 1 per cent.
T. P. B.

1576. *Flat Conductor in Cylindrical Alternating Field.* **F. Rusch.** (Jahrbuch d. Drahtlosen Telegraphie, 4. pp. 459–480, May, 1911.)—The paper is mathematical. The flat conductor is supposed to lie along a slit cut in iron, and it is shown that if $r=$ the a.c. resistance of the conductor, and r_0 its d.c. resistance, then $r=r_0(ax_1)(\sinh 2ax_1+\sin 2ax_1)/(\cosh 2ax_1-\cos 2ax_1)$, where $x_1=$ breadth of conductor and $a=2\pi\sqrt{(nc\delta/b)}$; $n=$ frequency, $c=$ conductivity, $\delta=$ thickness of conductor, $b=$ breadth of slit. A formula of a similar nature is also obtained for the change in the self-induction. A good approximate formula for the resistance is given by $r=r_0ax_1$. The case of several plates, placed side by side and over one another, but insulated from each other, is also considered. [See also Abstract No. 979 (1910).] T. P. B.

1577. *Influence of Temperature on the Magnetic Properties of Carbon Steels.* **M. B. Moir.** (Roy. Soc., Edinburgh, Proc. 31. pp. 506–516, 1910–1911.)—The author has tested the variation with temperature of the susceptibility of a graded series of carbon steels, special precautions being taken to render the specimens perfectly neutral immediately before commencing each magnetic test. In addition to the general improvement in quality; for low magnetising fields, with increase of temperature up to near the critical point, it is found that there is a minor decrease and subsequent recovery in the neighbourhood of 200° C. to 260° C. The phenomenon occurs at the higher temperature named, and is most marked in high-carbon steels and in cast iron. It is only feebly shown in mild steels, and the minimum point occurs at about 210° C. In iron almost free from carbon it is not noticeable. The observations therefore indicate a transformation-point in iron-carbon alloys at a temperature somewhat over 200° C. A. D. R.

1578. *The Magnetic Properties of some Nickel Steels. With some Notes on the Structure of Meteoric Iron.* **E. Colver-Glauert** and **S. Hilpert.** (Iron and Steel Inst., Journ. 83. pp. 375–407; Correspondence, pp. 408–411, 1911. Zeitschr. Elektrochem. 17. pp. 750–761, Sept. 1, 1911. Electrician, 67. pp. 786–787, Aug. 25, 1911. Abstract.)—The material tested consisted of commercial nickel steels with Ni-contents of 5·86, 24·32, and 32·9 per cent., carbon having the values 0·37, 0·24, 0·30 in the three respective cases. The following is the author's summary of conclusions: (1) A 5 per cent. Ni steel is hardest (magnetically) when quenched in the neighbourhood of 900° C. Quenching from higher temperatures results in a softer material. (2) The changes which occur during the thermal treatment of a 25 per cent. Ni-Fe alloy are of a very complicated nature. At high temperatures there probably exists a product which may be preserved by rapid quenching, and is then strongly magnetic, and persists to the temperature of liquid air. This product does not exist in the region between about 600° C. and 900° C., but another which is also magnetic, can possibly occur at about 800° C. There is no sharp magnetic change-point for this alloy below zero, but the permeability gradually increases as the temperature decreases from about −50° C. to −180° C. (3) The magnetic properties of a 33 per cent. Ni-Fe alloy are only very slightly affected by thermal treatment. Despite the "γ iron structure" produced on this steel by the more general etching media, it is strongly magnetic and soft. (4) There is no connection between magnetic properties and microstructure. (5) There is no evidence that if γ iron exists it is non-magnetic. (6) The microstructure of commercial Ni steel is practically the same as that of meteoric iron. L. H. W.

1579. *Magneto-elastic Phenomena in Iron and Nickel.* **G. Ercolini.** (N. Cimento, 2. Ser. 6. pp. 218–222, Sept., 1911.)—A decreasing alternate magnetic field of 50·7 units reduces and nearly abolishes the magnetic hysteresis in stretched iron and nickel. In twisted iron it does the same, but not in twisted nickel. In the latter, however, it annuls the Nagaoka-effect. In every case the variations of magnetic moment produced by the deformations of iron and nickel in an alternating field on which a constant field is superposed, are different in amount, and sometimes in sign, from those which are produced by carrying out the deformations in a constant field, and then reducing the magnetic hysteresis by means of an alternating field. Under the constant action of the latter effects take place which can only be interpreted when it is known why the reversible magnetisation obtained in the alternating field differs from the ordinary non-hysteretic magnetisation. [See Abstracts Nos. 1807 (1908), 674 and 1226 (1911).] E. E. F.

1580. *Effect of Transverse Joints on the Magnetism of Nickel Bars.* **E. H. Williams.** (Phys. Rev. 33. pp. 60-64, July, 1911.)—Ewing and Low have shown that the influence of transverse joints in iron bars is to produce a large magnetic resistance which can, however, be reduced by longitudinal pressure. As thin layers of nickel, unlike those of iron, are more highly magnetic than thick layers [see Abstract No. 1372 (1902)], it would appear that transverse joints should result in an increase of magnetic induction. The author has investigated this by apparatus similar to that used by Ewing for iron. The bar was first tested without any cuts, after which it was cut in two in the middle, and re-tested, the plane cut ends being pressed into contact. Further trials were made with two and four cuts, and with various longitudinal compressions up to 135 kg./cm.^{2}. It is found that with nickel, for H greater than 20 to 25 c.g.s. units, depending on the pressure, the effect of the surface layers more than counterbalances the effect of the magnetic resistance of the air-gap, thus producing an increase in the magnetic induction. With iron there is a decreased magnetic induction irrespective of the pressure or magnetising field. It is noteworthy that the percentage increase in induction reaches a definite maximum for $H = 70$ about. The results make it evident that the effect of the surface layers is due to two or more causes, and that it does not follow any simple law. Incidentally a Villari critical point between $H = 150$ and $H = 200$ c.g.s. units was observed. A. D. R.

1581. *Electron Theory of Ferromagnetism.* **R. Gans.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 118-164, 1911.)—The author in a previous paper [Abstract No. 1517 (1910)] gave an outline of a theory of ferromagnetism in which he employed the idea of an elementary magnet (the magneton) which is an electrically charged body rotating rapidly about its axis of figure, while an "elementary complex" consists of a group of such magnetons. In the present communication further attention is directed to temperature effects, and as a result of a simplification in the method of the mathematical analysis, the author is enabled to connect up the thermal with the magnetic phenomena. He thus finds that the magneton within the elementary complex must be of given fixed form and move about like the molecules of a gas impinging on one another and diverting one another in their paths when near approaches occur. This thermal agitation can be measured, and thus a formula is obtained for the magnetisation curve of the elementary complex in which the temperature enters as a parameter. A. D. R.

1582. *Coefficients of Magnetisation of Gold.* **M. Hanriot and F. Raoult.** (Comptes Rendus, 153. pp. 182-185, July 17, 1911.)—The coefficients of magnetisation of brown gold and of ordinary gold obtained therefrom by calcination have been measured by the magnetic balance, and found to range from $-0{\cdot}120$ to $-0{\cdot}181 \times 10^{-6}$ and from $-0{\cdot}160$ to $-0{\cdot}284 \times 10^{-6}$ respectively, the lower values in each case being due to the presence of iron, and the maxima being obtained with gold subjected to 6 successive treatments with boiling nitric acid. The ratio of the two coefficients is approximately constant. The coefficient for brown gold increases on heating for some time to 400° C., after 30 min. being $-0{\cdot}1870 \times 10^{-6}$, after 1 hour $-0{\cdot}1464 \times 10^{-6}$, after 2 hours $-0{\cdot}1601 \times 10^{-6}$, and after 5 hours $-0{\cdot}1600 \times 10^{-6}$, showing that the transformation into ordinary gold is almost complete after 2 hours. At higher temperatures the same change takes place, but is much more rapid. The proportion of silver in the alloy from which the brown gold is prepared, has a considerable influence on its coefficient of magnetisation, the ratio of the coefficients before and after burning decreasing continuously with increase of silver in the original alloy. W. H. St.

1583. *Hall-effect in Copper Iodide.* **K. Steinberg.** (Ann. d. Physik, 35. 5. pp. 1009–1038, Sept. 1, 1911. Abstract of Dissertation. Jena.)—The paper describes experiments on the Hall-effect in copper preparations containing iodine. Particulars are given of the apparatus, the method of preparing the materials and of experimenting, and the results. Tests were also made on the change in the resistance of copper iodide when placed in a magnetic field. The chief conclusions are as follows: (1) In the Hall-effect in CuI the transverse force is proportional to the primary current for the range investigated, viz., with a current density of 0·15 to 23·0 amps./cm.^{2}. (2) The transverse force is proportional to the magnetic field for a range up to 20 kilogauss. (3) The sign of the rotation coefficient is positive. (4) The magnitude of the coefficient depends on the iodine-content of the CuI and also on the specific resistance of the material. The coefficient increases with increasing specific resistance of the CuI, at first slowly, then more quickly, and finally it increases proportionally to the resistance. These results are in full agreement with theory. (5) For the longitudinal effect it is found that with a certain iodine concentration the change in the resistance in a magnetic field of 20 kilogauss amounts to less than 0·00001 per cent. A. D. R.

1584. *Simultaneity of Magnetic Disturbances.* **K. Birkeland.** (Nature, 87. pp. 483–484, Oct. 12, 1911.)—The author discusses the times of commencement of the abruptly beginning magnetic storm of April 9, 1911, as recorded at several magnetic observing stations. He shows that, within the limits of error in the observations, the changes in declination and in vertical intensity occurred around the terrestrial equator simultaneously. This result is in harmony with his theory that such storms are due to kathode rays sent out by the sun towards the earth. A. D. R.

1585. *Magnetic Storms and Polar Aurora.* **K. Birkeland.** (Archives des Sciences, 32. pp. 97–116, Aug., 1911.)—The paper summarises a long series of observations made during recent years on the artificial production of phenomena resembling auroral discharges, and their relation to terrestrial magnetic storms. Detailed studies have been made of the magnetograph traces at 25 stations, showing the exact amount and direction of the variations of the magnetic components during notable storms. Evidence is given of the existence of equatoral positive and negative storms, and polar positive and negative storms. There appears to be a relation between the sign of the disturbance and the position of the sun with respect to the earth. Numerous photographs have been taken of the luminous precipitations formed on a magnetic sphere suspended in a vessel and subjected to the action of kathodic ays. Several of these are reproduced in the paper. C. P. B.

REFERENCES.

1586. *Motion of Electron near Charged Sphere.* **K. Tamaki.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 137–140, July, 1911.)—Deduces the hyperbolic orbit of an electron near a negatively-charged sphere. E. H. B.

1587. *Electromagnetic Fields in a Moving System.* **K. Tamaki.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 103–111 and 113–119, July, 1911.)—A highly analytical treatment of the general and fundamental equations for electromagnetic fields in a moving system on the basis of the principle of relativity. E. H. B.

1588. *Electromagnetic Field in a Moving Body.* **K. Tamaki.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 141–153, July, 1911.)—This case, already treated by the author [see preceding Abstract] by the establishment of a system of transformation equations, is here dealt with by use of the four-dimensional vector analysis. The co-ordinates of this four-dimensional space are x, y, z and $i\,c\,t$ where c is the light speed in vacuum and $i = \sqrt{-1}$, and the results reached are in agreement with those previously obtained by the other method. [See Abstracts Nos. 1990 (1908) and 23 (1911).] E. H. B.

1589. *Electromagnetic Equations with Linear Transformations of Co-ordinates.* **P. Frank.** (Ann. d. Physik, 35. 3. pp. 599–607, July 11, 1911.)—Following the work of H. A. Lorentz, of H. Minkowski, of A. Sommerfeld, and of H. Bateman, the present author discusses by the four-dimensional vector calculus the behaviour of the electromagnetic field equations when the space and time co-ordinates suffer linear transformations. [See Abstracts Nos. 1215 (1910) and 31 (1911).] E. H. B.

1590. *Selenium.* **G. L. Addenbrooke.** (Electrician, 67. pp. 591–592, July 21, 1911.)—A summary of some recent researches, notably those of Threlfall, [Abstract No. 1772 (1907)], and of Mason and Vonwiller [Abstract No. 1903 (1907).] E. E. F.

1591. *Initial Accelerated Motion of a Rigidly Charged Dielectric Sphere.* **G. H. Livens.** (Phil. Mag. 22. pp. 169–173, July, 1911.)

1592. *Crystal-Metal Contact Detectors of Electric Oscillations.* **M. Kimura** and **K. Yamamoto.** (Coll. Sci. and Engin., Mem., Kyōtō, 2. 4. pp. 83–106, 1910.) —An account of further experiments on the same lines as those dealt with in Abstract No. 1492 (1910). L. H. W.

1593. *Measurement of Contact Differences of Potential.* **A. Anderson** and **J. E. Bowen.** (Phys. Soc., Proc. 23. pp. 346–350, Aug., 1911.)—Describes two methods, a deflection method and a null method. L. H. W.

1594. *Hydroelectric Machines.* **A. Bernini.** (N. Cimento, 1. Ser. 6. pp. 343–374, May, 1911.)—A systematic study of the machines devised by Kelvin, S. P. Thompson, and Fuller, together with a description of some improvements. One of these relates to the complete enclosure of the water-jets, thus providing for their use in windy weather out of doors. E. E. F.

1595. *Variation of the Electrical Conductivity of Iron with Temperature.* **A. R. Meyer.** (Deutsch. Phys. Gesell., Verh. 13. 17. pp. 680–692, Sept. 15, 1911. Extract of Dissertation, Greifswald. Elektrotechnik u. Maschinenbau, 29. pp. 905–906, Oct. 29, 1911. Abstract.)—The author has investigated for three differently prepared samples of very pure iron how closely they obey, through the range from 0° to 1000° C., the following relations deduced from Stefan's law:—

$$\text{(i) } \log W = a + m \log T \quad \text{and} \quad \text{(ii) } \log i = c + q \log T.$$

Diagrams are given showing the close agreement obtained. A. D. R.

1596. *Dielectric Constant of India-rubber.* **L. Schiller.** (Ann. d. Physik, 35. 5. pp. 931–982, Sept. 1, 1911. Abstract of Dissertation, Leipzig.)—Deals with the change in the dielectric constant with extension of the rubber in a direction perpendicular to the lines of force. F. E. S.

1597. *Theory of Hall-effect.* **O. M. Corbino.** (Accad. Lincei, Atti, 20. pp. 914–920, June 18, 1911. N. Cimento, 2. Ser. 6. pp. 39–46, July, 1911. Phys. Zeitschr. 12. pp. 842–845, Oct. 15, 1911.)—Works out formulæ for the Hall-effect involving fewer variables than those of Drude and Zahn, and therefore more amenable to experiment. Similar formulæ may be used for calculating the radial thermo- and galvano-magnetic effects recently discovered by the author. E. E. F.

1598. *Behaviour of Solutions of Magnetic Salts in a Magnetic Field.* **C. Statescu.** (Comptes Rendus, 153. pp. 547–549, Sept. 11, 1911.)—The author describes an experiment to show the way in which a heterogeneous solution of a magnetic salt will arrange itself in a magnetic field which is not uniform. The layers of varying concentration are exhibited by an optical method. A. D. R.

1599. *Magnetic Induction in an Ellipsoid of Revolution in a Uniform Field.* **E. Daniele.** (N. Cimento, 2. Ser. 6. pp. 131–140, Aug., 1911.)—Mathematical.

1600. *Comparisons of Magnetic Observatory Standards by the Carnegie Institution of Washington.* I. **J. A. Fleming.** (Terrestrial Magnetism, 16. pp. 61–84, June, and pp. 137–162, Sept., 1911.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1601. *Periodic System of the Elements.* **W. Biltz.** (Zeitschr. Elektrochem. 17. pp. 670–673; Discussion, p. 674, Aug. 15, 1911. Paper read before 18. Hauptversamml. d. Deutch. Bunsen-Gesell., Kiel, May, 1911.)—A new periodic system is based upon the conception of atomic oscillations or proper frequencies. These can either be calculated by Einstein's formula from atomic heats at low temperatures, or according to Lindemann, from the absolute melting-point T, the atomic volume v, and the atomic weight m, the formula for the frequency being $2{\cdot}12 \times 10^{12} (T/mv^{2/3})^{1/2}$. Both methods give concordant results. In the resulting periodic curve there are 5 chief maxima, headed by carbon with a frequency of 24×10^{12}, Si ($7{\cdot}3 \times 10^{12}$), the iron group (6·3), the Pd group (about 4·8), and the Pt group (about 3·9) respectively. The minimum frequencies are possessed by He (0·5), Ne (0·26), Kr (0·70), Xe (0·64), and Hg (0·95) respectively. The maxima are occupied by elements forming stable complex compounds, carbon being, as befits the complexity of its compounds, very far above the rest. This exceptional position of carbon is a distinct improvement on other periodic systems. E. E. F.

1602. *Radio-activity and the Periodic System.* **T. Wulf.** (Annal. Soc. Sci. de Bruxelles, 35. 3 and 4. pp. 283–292, 1910–1911.)—Assuming that all elements are more or less radio-active, we should expect their atomic weights to differ by four or multiples of four, this being the atomic weight of the α-particle or He atom. The above hypothesis is supported by an inspection of the table of known atomic weights; for we have the two series: 12, 16, 20, 32, 40, 44, 48, &c., and 19, 23, 27, 31, &c., which are the atomic weights of known elements. The author therefore considers the atoms in two groups, the atomic weights being represented by $4n$ and $4n-1$ respectively, n being any integer. E. M.

1603. *Molecular Weight of Thorium Emanation.* **Mlle. M. S. Leslie.** (Comptes Rendus, 153. pp. 328–330, July 31, 1911.)—The molecular weight of ThEm was determined by measuring its rate of effusion through a small hole, using a method similar to that of Debierne in his determination of the molecular weight of RaEm [Abstract No. 1150 (1910)]. The measurements were made by the activity of the active deposit, allowance being made for the decay; while the rate of effusion was compared with that of oxygen and the molecular weight assumed to vary as the inverse square of the coefficient of effusion. The mean value found was about 200. E. M.

1604. *Thulium. I.* **C. James.** (Amer. Chem. Soc., Journ. 33. pp. 1332–1344, Aug., 1911. Abstract.)—The best sources of the element were found to be ytterspar, euxenite, and a columbate from an island in the north of Norway. Gadolinite varied very considerably, some varieties being fairly good, whilst most were rather poor in the erbium earths. A specimen of samarskite was found to resemble euxenite with regard to its content of erbium metals. The details of the processes for the extraction of the mixed rare earths are given at some length. The fractionation methods of separating thulium are also given in detail. The various fractions were mixed according to their purity, the purest product being reserved for a determination of the equivalent, which will form the main subject of the next paper on thulium. The fractions not quite so pure were used for the preparation of many compounds, some of which are described. The most important point proved by this work is that the element giving the characteristic absorption bands of thulium cannot be separated into simpler substances. After about 15,000 operations the absorption spectrum underwent no change. [See Abstract No. 1487 (1911).] A. W.

1605. *Chemical Effects of Radium Radiations.* **S. C. Lind.** (Le Radium, 8. pp. 289–292, Aug., 1911.)—The present experiments deal with quantitative measurements on the effect of Ra radiations on HBr and KI. With strong β-and γ-radiations from 200 mgm. of $RaCl_2$ no chemical effect was detectable on either gaseous HBr or on a mixture of H and Br, although the radiations were allowed to act for 87 days. A small combination effect, 2·6 per cent. in 14 days, was produced by mixing 1 mgm. RaEm equivalent with each c.cm. of a mixture of ½ atmo. Br with ½ atmo. H, this effect, however, being much less than that with H and Cl [see Abstract No. 1696 (1907)], while a separate experiment showed no greater effect of the RaEm at 300° C. Experiments with liquid anhydrous HBr, however, showed that the presence of RaEm caused partial decomposition and a calculation revealed that 8·5 per cent. of the energy of the radiations was accounted for by this chemical action. Experiments were also made on the action of the various radiations on solutions of KI under different conditions as regards dilution and admixture of acids. Iodine was liberated in all cases, the amount increasing with the concentration but not proportionally, while the presence of acid considerably increased the effect. E. M.

1606. *Action of the High-tension Arc on Carbon Dioxide and on Gas Mixtures.* **W. Muthmann** and **A. Schaidhauf.** (Zeitschr. Elektrochem. 17. pp. 497–508, July 1, 1911.)—The experiments form a continuation of others in which H. Hofer and A. Geitz had taken part. Alternating currents of 25 ∿ are fed into an oil-insulated transformer, and the arc-flame is produced between electrodes of gold, silver, and platinum, which show peculiar differences. CO_2 is split into CO and O, and the best yield is, in the case of gold electrodes, obtained with short arcs of about 0·2 cm. length; an arc of 1 cm. length could not be maintained, because the one or the other rod electrode would suddenly fuse for unknown reasons. Similarly, partial explosions would suddenly start in mixtures of CO_2, CO, O; in this case the traces of moisture in the gas were apparently important; the moisture gained access through the corks of the glass tubes, the gas mixture being under an excess pressure of 40 cm. of water. Silver electrodes behaved like gold electrodes, but they never fused. Platinum electrodes behaved differently; with short arcs the yield was very small, and it was only when the arc reached a length of 1 cm. that the phenomena became similar; there is apparently a catalytic effect with Pt electrodes, especially when the arc is short. A mixture of nitrogen and CO_2 gave NO and CO; but the NO-yield was not improved by the addition of CO_2 to the air, which was technically known. A mixture of methane and nitrogen yields prussic acid to the complete exhaustion of the methane, provided the formation of a carbon bridge between the electrodes (Pt or Au) be prevented by the dilution of the gas with hydrogen. Attempts to estimate the temperature of the arc from the dissociation of CO_2 gave values which were too small probably by 600° C., because CO_2 was being re-formed in the arc (Ag-electrodes). A literature list is added to the paper. H. B.

1607. *Ozone-formation, Current Frequency, and Wave-form.* **G. Lechner** (Zeitschr. Elektrochem. 17. pp. 414–420, June 1, 1911. Extract of Dissertation, Budapest, 1909.)—The oxygen to be ozonised was generated by electrolysis of caustic soda with nickel electrodes; the diaphragm of three layers of parchment paper and two of linen had a low resistance, and lasted several weeks. The two compartments of the eletrolyser were joined by a syphon to neutralise kataphoresis. The hydrogen in the oxygen was burned out with copper oxide. The current of accumulator cells was interrupted by mercury jets under petroleum or alcohol, up to 240 times per sec. The ozone-yields increased with the frequency, at first rapidly. There was no direct relation between effective tension (Braun electrometer) and ozone-yield; at constant ozone concentration and equal periods of closed circuit the yield was proportional to the number of interruptions; but the essential feature seemed to be the max. tension of a current impulse, and varied experiments proved the complicated character of the phenomena. Alternating currents gave very much less ozone than direct currents of equal voltage and frequency (42), chiefly perhaps because the alternating-current curves were much flatter than those of the interrupted currents, and because the apparatus began to spark at high potentials. H. B.

1608. *Synthesis of Oxygenated Water by the Electric Discharge.* **A. de Hemptinne.** (Annal. Soc. Sci. de Bruxelles, 35. 3 and 4. pp. 328–338, 1910–1911.)—The author and Stappers pass hydrogen through various apparatus and observe the discoloration of potassium permanganate. As a rule two apparatus, I and II, are coupled in series with a Tesla coil. The apparatus resemble ozonisers, being concentric glass tubes, sulphuric acid inside, tin-foil outside. The hydrogen passes in succession through apparatus I, the permanganate solution, H_2SO_4, P_2O_5, KOH, apparatus II, and again permanganate. When the hydrogen is quite free from oxygen, no discoloration is observed; the effect is small also when several per cent. of oxygen are present, possibly because ozone is also formed. When several apparatus are connected with a static electric machine, the discoloration is noticed only at the negative pole. Electric sparks and hot wires have similar effects, X-rays and ultra-violet rays have no effect. The author concludes that oxygenated water and some water are formed, and that the effect, which is only temporary, is due to an activation of the hydrogen (particularly when dry), caused by the splitting-off of electrons. H. B.

1609. *Silent Electric Discharge through Gases at Atmospheric Pressure.* **E. H. Riesenfeld.** (Zeitschr. Elektrochem. 17. pp. 725–731, Sept. 1, 1911. Paper read before the 18. Hauptversamml. d. Deutsch. Bunsen-Gesell., Kiel, May, 1911.)—The apparatus are of the Jannasch type (glass tubes and sulphuric acid) and of several dimensions. The gases are purified, dried, and freed from dust. When the potential is slowly raised, the discharge (intermittent) becomes visible at a certain minimum potential, which is again observed when the potential is afterwards raised and once more lowered. The continuous discharge sets in at about 10 to 30 volts higher, but this continuous potential is less sharp. The order of the minimum potential is hydrogen (90 volts in the one apparatus), NO, oxygen (125 volts), CO_2, nitrogen (149 volts). When the potentials are referred to oxygen (ozone formation), the relative minima are independent of the dimensions of the apparatus and of the frequency. This order is approximately that of the spark discharges through the gases, and in general the minimum potential seems to be the higher, the more energy is required for the ozonisation (*i.e.*, the ejection of the electrons from the molecule). Such an electrochemical potential series is given for 30 gases. The colour of the discharge is pale-blue in hydrogen, green-blue in oxygen, pink in nitrogen; in Cl (300 volts) the luminous effect is intense, resembling the appearance of iron being burnt in oxygen. H. B.

1610. *Production of Prussic Acid in High-tension Arc.* **A. V. Lipinski.** (Zeitschr. Elektrochem. 17. pp. 761–764, Sept. 1, 1911.)—The preparation of HCN is disturbed by the liberation of sooty carbon, which is difficult to remove. A mixture of 20 per cent. of methane, 10 of hydrogen, 70 of nitrogen (the three gases being chemically generated) yields, however, 19 per cent. of HCN, almost without any formation of soot. The apparatus comprises a glass balloon of 50 litres with two horizontal electrodes, Pt-points on copper rods; any soot particles forming in the arc are removed with the aid of a glass rod. According to **I. Moscicki** (Ibid. p. 877, Oct. 1, 1911), the experiments were made in his own laboratory by Moscicki and K. Jablczynski in 1909; Lipinski merely took part as engineer, but applied for a German patent. H. B.

1611. *Alloys of Aluminium and Zinc.* **W. Rosenhain and S. L. Archbutt.** (Roy. Soc., Phil. Trans. 211. pp. 315–343, Sept. 7, 1911.)—An account is given of the constitution of the aluminium-zinc alloys. The materials employed in the investigation were of the highest purity available. The alloys were made in Salamander crucibles; in some cases a previously prepared 50 per cent. alloy was used. No flux was employed and all alloys for cooling-curve purposes were chemically analysed. For the cooling-curves, ingots weighing 300 gm. were used and it was found necessary to use a very slow rate of cooling. For the microscopic examination small pieces were, as a rule, cut from the ingots used for cooling-curve determinations. Most of the specimens were etched with a 10-per cent. solution of caustic potash; in one or two cases weak nitric acid was used. The equilibrium diagram is given, together with cooling-curves of some of the alloys, and photomicrographs. The general conclusions arrived at are: The addition of Al to Zn first depresses the freezing-point until a eutectic minimum is reached at 95 per cent. Zn and 380° C. Further additions of Al raise the freezing-point until 85 per cent. Zn is reached, when there is a small but distinct break in the freezing-point curve. From here the freezing-point curve rises smoothly until the freezing-point of pure Al is reached. The phases which commence to crystallise along the four branches of the liquidus curve are: (1) The α-phase which is Zn or Zn carrying in solid solution less than 1 per cent. of Al; (2) The β-phase, which is a definite compound, probably Al_2Zn_3. This compound has a tendency to crystallise in six-rayed dendrites; it has only a limited range of stable existence, being decomposed on heating above 443° C. into γ and liquid, and, on cooling below 256° C., breaking up into α and γ; (3) The γ-phase, which is a solid solution of Al containing up to approximately 40 per cent. of Zn. Between 40 and 85 per cent. Zn, this solid solution reacts with Zn, which may be present in either the liquid or solid form to produce Al_2Zn_3; from 78·3 to 85 per cent. Zn the product of this reaction is the free β compound with a residue of liquid, but between 40 and 78·3 per cent. Zn, the resulting compound dissolves in the residual solid γ-phase, forming a series of solid solutions. These solid solutions undergo decomposition on cooling to 256° C., separating into the α- and γ-phases. It is probable, although not definitely proved, that both these reactions are continued in the alloys lying between 40 per cent. Zn and pure Al. The diagram differs from that given by Shepherd and others in showing the two horizontal lines of heat evolutions at 443° C. and 256° C. [A paper on the same subject was read by the Authors before the Inst. of Metals, Sept. 21, 1911; see Engineering, 92. pp. 438–441, Sept. 29, 1911. See also Abstracts Nos. 1959 (1905) and 1840 (1910).] C. O. B.

1612. *Tellurium-Zinc.* **M. Kobayashi.** (Coll. Sci. Engin., Mem., Kyōtō, 3. pp. 217–221, Aug., 1911.)—Thermal analysis of this system shows that the two elements give rise to the compound TeZn corresponding to a maximum in the liquidus at 1238·5° C. It has a specific gravity of 5·54, is soluble in Te but only very slightly soluble in Zn. F. C. A. H. L.

1613. *Metallographic and Photochemical Researches on the Sulphur-Tellurium System.* **M. Chikashigé.** (Coll. Sci. and Engin., Mem., Kyōtō, 3. pp. 197–210, Aug., 1911. Zeitschr. Anorg. Chem. 72. 2. pp. 109–118, Sept. 22, 1911.)—The constituents were melted together in a stream of CO_2 and cooling-curves were taken by means of a mercury thermometer. Sulphur and tellurium do not give rise to compounds but form solid solutions at both ends of the series, the liquidus falling to a eutectic at 7 per cent. Te and 109° C. The saturated Te-rich solid solution contains 2 per cent. S and undergoes no transformations below the solidification-point. At the other end of the series, S undergoes in the liquid, several transformations, whose temperatures are lowered by Te. γ sulphur (400° C.) dissolves 20 per cent. Te, molten β sulphur about 10 per cent. Te, and solid β sulphur only 2 per cent. Te. The β solid solutions are transformed into the α form only very slowly in the dark and at ordinary temperatures, but the change is accelerated by intense cold or the action of light. α sulphur retains only 0·5 per cent. Te in solid solution. The sensitivity to light has been tested by exposure under various coloured glasses. All the β solid solutions containing from 0·5 to 2 per cent. Te are affected by light; rays of wave-length = 450 having the maximum effect. Solid solutions containing less than 0·5 per cent. Te, which include the Japanese red sulphur, are not affected by light. F. C. A. H. L.

1614. *Compounds of Silver with Cadmium.* **G. J. Petrenko** and **A. S. Fedorow.** (Zeitschr. Anorg. Chem. 71. 3. pp. 215–218, July 7, 1911.)—The existence of the compounds $AgCd_4$, $AgCd_3$, Ag_2Cd_3 and AgCd has previously been assumed on both thermal and microscopical grounds [see Abstracts Nos. 161, 968 (1911)], but since neither $AgCd_4$ nor $AgCd_3$ show transition-points in the solid, there seems some doubt as to their actual existence. By means of annealing alloys containing 18·8 to 19·5 per cent. Ag at 320 to 330° C., and quenching from 510 to 520° C., the authors have found that the compound $AgCd_4$ does not exist. An alloy corresponding to its composition showed a distinct duplex structure after quenching from 520° C., instead of the polygonal structure indicating the presence of the compound. Experiments on the existence of $AgCd_3$ showed that samples quenched from 555 to 560° C. had a polygonal structure, but other methods will have to be applied before the point can be decided with certainty. F. C. A. H. L.

1615. *Lithium Amalgams.* **G. J. Żukowsky.** (Ber. d. Polytechn. Inst. St. Petersburg, 14. p. 655, 1910. Zeitschr. Anorg. Chem. 71. 4. pp. 403–418, Aug. 10, 1911.)—The lithium amalgams have been investigated by the methods of thermal analysis using a copper-constantan thermo-couple and a

Kurnakow registering pyrometer. On account of the violent reaction between the two metals and the attack of silicious materials by Li, alloys were prepared in covered iron vessels; paraffin, the eutectic mixture of RbCl + LiCl or KCl + LiCl being used, to prevent oxidation, according to the temperature. The temperature-concentration curve indicates the existence of the compounds Li_3Hg, LiHg, $LiHg_2$, $LiHg_3$, the compound LiHg corresponding to the single maximum at 600·5° C. In this, the system differs from the other amalgams in which the maximum is situated at a composition corresponding to the compound RHg_2. The existence of the compound $LiHg_3$ was confirmed by applying the Berthelot calorimetric method to alloys containing 50 to 75 atoms per cent. Hg. A table showing the relations of Li to Mg on the one hand, and Na, K, and Cs on the other, with regard to the tendency to form compounds with Zn, Cd, and Hg, is included in the paper. The tendency to form compound amalgams increases with the atomic weight.

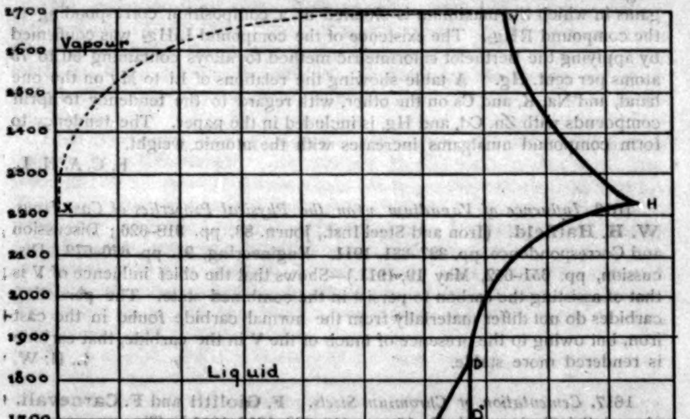
F. C. A. H. L.

1616. *Influence of Vanadium upon the Physical Properties of Cast Irons.* **W. H. Hatfield.** (Iron and Steel Inst., Journ. 83. pp. 318–326; Discussion and Correspondence, pp. 327–331, 1911. Engineering, 91. pp. 670–672; Discussion, pp. 651–652, May 19, 1911.)—Shows that the chief influence of V is that of assisting the carbon to persist in the combined state. The persisting carbides do not differ materially from the normal carbide found in the cast iron, but owing to the presence of much of the V in the carbide, that carbide is rendered more stable. L. H. W.

1617. *Cementation of Chromium Steels.* **F. Giolitti** and **F. Carnevali.** (Accad. Sci. Torino, Atti, 46. 10. pp. 412–422, 1910–1911.)—The cementation is studied of a chromium steel containing 2·38 per cent. Cr, 0·41 C, 0·15 Si, and 1·02 per cent. Mn, the carburising agents being ethylene, CO, or carbon and CO_2, and the results obtained are analogous to those already published for other classes of steel [Abstract No. 1271 (1911)]. Under identical conditions, and using as carburising agent a mixture of carbon and CO_2, if cementation is prolonged so that a carburised zone of more than 3 mm. thickness is produced, the max. concentration of carbon in this zone in the case of Cr steel is notably higher than with an ordinary steel, so that for Cr steels the conditions of cementation have to be so modified as to reduce this concentration. W. H. Si.

1618. *Internal Structure of Martensite and Pearlite.* **M. Oknof.** (Metallurgie, 8. pp. 539–541, Sept. 8, 1911.)—The method previously described [see Abstract No. 802 (1911)] has been applied to the study of martensite and pearlite, the layers removed at each polishing varying from 0·015 mm. in the case of martensite to 0·01 mm. in the case of pearlite. From an examination of the eighteen photomicrographs it appears that martensite forms flat lamellar crystals which are about seven times as long as they are wide. Pearlite consists of narrow curved layers of cementite embedded in a mass of ferrite. Few of the cementite layers cross and flow into each other, most of them remaining parallel in the succeeding layers. The lamellæ of martensite and pearlite are of different dimensions. F. C. A. H. L.

1619. *Constitution Diagram of the Iron-Carbon Alloys.* **O. Ruff.** (Metallurgie, 8. pp. 456–464, Aug. 8, and pp. 497–508, Aug. 22, 1911.)—The determinations of the solubilities described in a previous paper [Abstract No. 1406 (1911)] have been used to extend the temperature-concentration diagram as shown in the accompanying Fig. Of the new lines, BDHY is the saturation curve for graphite at high temperatures, while XY has been added as a result of experiments on the volatilisation of pure iron and the alloys. It marks the upper limit of the diagram and the appearance of the vapour phase. The general conclusions to be drawn from a critical examination of the diagram are as



follows: Two carbides exist, triferrocarbide Fe_3C (cementite) corresponding to the point D, and diferrocarbide Fe_2C, corresponding to the point H. Both carbides are endothermic, at all events above 700° C. At 2220° C. there are strong indications of the dissociation of the diferrocarbide in two stages, $Fe_2C \rightleftarrows FeC + C$ and $FeC \rightleftarrows FeC + C$. As the temperature decreases, the diferrocarbide decomposes at 1887°.C., according to the equation

$3Fe_2C \rightleftarrows 2Fe_3C + C$. Solidification of the alloys may occur in the stable or metastable system. In the stable system the only solid separating is graphite, while in the metastable system, solidification occurs in four stages: (i) Period up to the arrival at the equilibrium concentration; (ii) Period between the equilibrium and the attainment of the saturation concentration; (iii) Solidification of the carbide eutectic; (iv) Cooling of the solid system. The quantity of carbide separating from the liquid phase is determined by the velocity of decomposition of the carbide, the distance of its equilibrium concentration from the saturation concentration and on the rate of solidification. Since the latter is a measure of the degree of supercooling, it determines the temperature of solidification and the velocity of decomposition. In the solid phase the velocity of decomposition is smaller than in the liquid phase, and as a result the carbide remains more stable on continued cooling, the lower the temperature at which it was separated. The state of division also affects the stability of the solid carbide, and the finer it separates the more easily it can persist in a state of metastable equilibrium with the surrounding solid solution. The horizontal of the carbide eutectic runs between 1128° and 1135° C., the distance between the equilibrium and saturation concentrations amounting to about 2·25 per cent. carbide at this temperature. The reaction velocity of the carbide decomposition at 1135° C. is under the given conditions, of the order that about 50 per cent. of the carbide decomposes in 2 seconds. Approximate formulæ have been worked out for calculating the composition of the constituents obtained on solidification (*a*) during the second period, and (*b*) during the third period of solidification, presupposing a definite reaction velocity. F. C. A. H. L.

1620. *Conductance of Aqueous Solutions of Sodium Chloride, Hydrochloric Acid and their Mixtures.* **W. C. Bray** and **F. L. Hunt.** (Amer. Chem. Soc., Journ. 33. pp. 781–795, June, 1911.)—Measurements were made at 25° of the conductance of 0·001 to 0·2 normal solutions of sodium chloride and of hydrochloric acid, and of mixtures of them in which the concentrations were varied systematically. The experimental values were compared with figures calculated (1) on the common assumption that the equivalent conductance of each salt in the mixture is the same as it would be in a solution of the same salt alone at equal ionic concentration, and (2) at equal total concentration. As the ionisations of sodium and hydrogen chloride are similar at equal concentrations, these two methods of calculation gave very similar results; but these were always higher than the experimental figures, the difference rising to 1·6 per cent. at 0·1 normal concentration. The suggestion is made that the conductance of an ion may depend upon its actual concentration rather than upon the total ion concentration, and it is shown to be possible to obtain a satisfactory agreement between the measured and calculated values by assuming that this is true for the hydrogen ion, and that hydrochloric acid is ionised to about the same extent as potassium chloride. The ratio of the specific conductances at 25° and 18° was determined for $0{\cdot}01n$KCl, $0{\cdot}05n$HCl and a number of sodium chloride solutions. Déguisne's results are confirmed for the first two solutions, but seem to be about 0·15 per cent. too low in the case of the sodium chloride solutions. T. M. L.

1621. *Conductivity and Viscosity in Mixed Solvents containing Glycerol.* **J. S. Guy** and **H. C. Jones.** (Amer. Chem. Journ. 46. pp. 131–197, Aug., 1911.)—Data are given for the molecular conductivity and viscosity of solutions of various salts in mixtures of glycerol with water, methyl alcohol and ethyl alcohol. Some evidence is given for the existence of glycerolates. Whilst the majority of salts increase the viscosity of glycerol, yet certain salts of rubidium and ammonium lower its viscosity. T. M. L.

1622. *Conductance and Ionisation of Certain Salts at 18° and 25°.* **F. L. Hunt.** (Amer. Chem. Soc., Journ. 33. pp. 795–803, June, 1911.)—The equivalent conductance at 25° and 18° was determined for a series of uni-bivalent salts at concentrations from 1 to 200 millimols per litre. It was found that the coefficient of ionisation γ, which was slightly less at 25° than at 18°, was the same for magnesium nitrate, and chloride; potassium bromate and nitrate gave similar values, but barium bromate was less ionised than barium nitrate and thallous sulphate less than silver sulphate; the two latter salts are less ionised than lead nitrate, and all three are much less ionised than the majority of uni-bivalent salts; the ionisation is even less in the case of lead and cadmium chlorides. It is suggested that the uni-bivalent salts are normally ionised to a considerable extent, but that many salts of Ag, Tl, Pb, and Cd are less ionised than typical salts of this type, and thus occupy an intermediate position between typical strong electrolytes and weak electrolytes such as mercuric chloride. T. M. L.

1623. *The Possible Solid Solution of Water in Crystals.* **T. W. Richards.** (Amer. Chem. Soc., Journ. 33. pp. 888–893, June, 1911.)—It is pointed out that not only inclusion, but also *solid solution*, of solvent in crystals is to be feared in precise quantitative work. Such solid solution could neither be easily detected nor easily eliminated. The solids obtained from an environment containing other substances, such as a solution, are therefore not safely available for exact quantitative work without further treatment. It is pointed out that these considerations afford an adequate explanation for the anomalous results concerning cadmium sulphate obtained by Perdue and Hulett. Therefore no reason for suspecting an error in the accepted atomic weight of Cd seems to be indicated by these results. T. M. L.

1624. *Solubility of Electrolytes in Aqueous Solutions.* I. *Solubility of Salts in the corresponding Acids.* **J. I. O. Masson.** (Chem. Soc., Journ. 99. pp. 1132–1139, June, 1911.)—Experiments were carried out to test Engel's rule that for moderate strengths of acid the introduction of acid into the saturated salt solution precipitates a chemically equivalent quantity of salt, attention being directed chiefly to cases and to concentrations for which Engel's rule does not apply. The solubilities measured were those of sodium and barium chlorides in hydrochloric acid and silver and barium nitrate in nitric acid at 30. Although Engel's rule ($-da/db=1$) does not apply, especially to the nitrates, the modified equation $-da/db=h_0+ha/b$ represents with considerable accuracy almost the entire course of all four curves and also holds when applied to the results obtained at 0° by Engel for numerous salt-acid solutions. In this equation a and b are the concentrations of acid and salt in gm.-mols. per litre at 30° and h_0 and h are constants. Two formulæ are given whereby the specific gravities of the solutions may be calculated: it appears from these that the molecular volumes of water, acid and salt remain constant through wide ranges of concentration. T. M. L.

1625. *Diffusion of Electrolytes in Aqueous Solutions.* **O. Scarpa.** (N. Cimento, 1. Ser. 6. pp. 320–334, May, 1911.)—Continuing his study of the subject [Abstract No. 1804 (1910)], the author shows that Vanzetti's results

[Abstract No. 2145 (1909)] were vitiated not only by the great difficulty in observing the exact point of precipitation, but also by the variation in the hydrostatic equilibrium, and more considerably by the supersaturation of the silver haloid solution prior to precipitation. Repeating Vanzetti's experiments, more definite readings were obtained by making three separate experiments with each pair of substances, the tube being merely rinsed with water after the first and second depositions of silver salt, and the point of deposition the third time being taken as the correct reading. The unsuitability of the method for the study of diffusion is confirmed. W. H. Si.

1626. *Osmotic Phenomena in Non-conducting Media.* **P. Bary.** (Comptes Rendus, 152. pp. 1766–1767, June 19, 1911.)—Experiments are described which support the author's view that colloidal solutions consist of solid-liquid granules in suspension in the solvent, transfer of liquid from the interior to the exterior of such granules taking place only by osmosis. Sulphur and certain resins dissolved in benzene or xylene are totally removed by osmosis through a membrane of vulcanised rubber, and though when a porous vessel containing a solution of acetyl collodion in tetrachlorethane is placed in tetrachlorethane nothing happens, if to the solution is added a substance soluble in both solvent and solute, *e.g.*, hexachlorethane, this passes through the vessel. Similarly, when a porous vessel containing a solution in benzene of caoutchouc, sulphur, and resins is immersed in benzene, the sulphur and resins pass through the vessel, leaving the caoutchouc. Since all semi-permeable membranes consist of colloids, they may be regarded as solid solutions, their permeability for a given body being proportional to its solubility in the colloid. W. H. Si.

1627. *Action of Aqueous Solutions of Single and Mixed Electrolytes upon Iron.* **J. N. Friend** and **J. H. Brown.** (Iron and Steel Inst., Journ. 83. pp. 125–144; Correspondence, pp. 145–146, 1911. Metallurgie, 8. pp. 660–666, Oct. 22, 1911.)—The addition of 1 gm. of potassium chromate per litre of water, corresponding to 10 lbs. of the salt per 1000 galls. of water, exerts a marked retarding effect upon corrosion. A further increase in concentration of the salt is even more beneficial in the presence of small amounts of sodium chloride, an excellent protection being secured with 100 lbs. per 1000 galls. L. H. W.

1628. *The Energy-change in Photochemical Processes in Gases.* **E. Warburg.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 36. pp. 746–754, 1911.)—The author has determined the "photochemical yield," or the fraction of the total radiation absorbed which is converted into chemical energy, in the case of ammonia. He finds that in the range of wave-lengths 0·208–0·214, the photochemical yield in the case of ammonia under a pressure of 80-90 cm. amounts to about 2 per cent. A. F

1629. *Chemical Polarisation of the Reversible Electrolytic Electrode.* **D. Reichinstein.** (Zeitschr. Elektrochem. 17. pp. 699–719, Aug. 15, 1911.)—In continuation of his researches [compare Abstracts Nos. 427 and 1285 (1911)] the author points out that the polarisation is much more due to chemical reactions at the surface of the electrode than to the slow diffusion phenomena caused by concentration-changes in the electrolyte. When a Pd kathode is immersed in sulphuric acid to which some zinc salt is added, the polarisation rises to such an extent that only Zn is deposited; this alloy Pd-Zn and the

Pd diffuse into the interior of the electrode and affect the reactions with the electrode. Similarly an oxygen alloy is formed on an anode. These diffusion phenomena, and hence the chemical reactions, will not take place at equal rates at the two electrodes, even if they are of the same material and dimensions. Thus one may speak of an effective electrode-volume, upon which the chemical reactions and consequent valve actions will depend. The author investigates these features and their dynamic characteristics with the aid of oscillographs and calculates the electrode volumes by experiments with various couples: Pt/H_2SO_4; Pb/$PbNO_3$ + HNO_3; Cu/$CuSO_4$ + H_2SO_4; Ni/$NiSO_4$ + H_2SO_4. H. B.

1630. *The Passive, Unpolarisable Sodium-amalgam Electrode.* **M. Le Blanc.** (Zeitschr. Elektrochem. 17. pp. 677–678; Discussion, pp. 678–679, Aug. 15, 1911. Paper read before the 18. Hauptversamml. d. Deutsch. Bunsen-Gesell., Kiel, May, 1911.)—As a rule, a body which dissolves under strong generation of hydrogen in an electrolyte is little polarisable in that solution. The converse does not necessarily hold, however; defective solubility and ready anodic polarisation do not always go together. The sodium-amalgam electrode of Lewis and Kraus is very constant in 0·2-*n* NaOH and does not generate hydrogen when the surface has repeatedly been renewed by letting the mercury drop off. The author finds that such a passive electrode is not polarised by alternating currents (when not too strong), and he explains this partly by assuming that the supply of hydrogen ions from the undissociated water is slow. This explanation was questioned by **O. Sackur.** Reference is made to B. Baker's observation that Na-amalgam does not liberate hydrogen from very pure water. H. B.

1631. *Ozone Formation by Alternating-current Electrolysis.* **H. v. Wartenberg.** Experiments by **E. H. Archibald.** (Zeitschr. Elektrochem. 17. pp. 812–816, Sept. 15, 1911.)—Alternating currents superposed upon direct currents have a depolarising effect. This was observed by Ruer in 1908, and by Bennewitz [see Abstract No. 1798 (1910)], and has further been investigated by E. Bürgin in his dissertation (Berlin, 1911). The authors find that the yield of ozone in the electrolysis of sulphuric acid is very much increased, and the voltage reduced by 8 volts, when alternating currents (density per $cm.^2 = A_2$) are superposed upon direct currents (density A_1), the ratio A_2/A_1 ranging up to 8. Their U-cell contains a Pt-foil as kathode and a Pt-wire, fused into a water-cooled glass tube, as anode. Acid density, anode surface, temperature, and frequency also affect the ozone-yield. For the separation of gold and silver the Norddeutsche Affinerie recommends the ratio $A_2/A_1 = 1{\cdot}7$ in order to prevent the liberation of chlorine. H. B.

1632. *Carbon-electrode Primary Cells of the Jacques Type.* **P. Bechterew.** (Zeitschr. Elektrochem. 17. pp. 851–877, Oct. 1, 1911.)—After a critical review of the literature the author describes an extensive series of experiments conducted under Kistiakowsky in St. Petersburg. The cells consist of a crucible of passive iron, heated up to 1400° C. by means of nickel wire or kryptol, and rods of lamp or retort carbon (also coke) in fused caustic soda or carbonates to which many additions are made. Electrode potentials are determined up to 650° by means of Haber's device, a pencil of caustic soda, over the lower end of which a glass tube is pushed, being used for effecting connection with the calomel electrode; a pencil of Portland cement was also applied. For determining the polarisations rolled-up nickel-foils are immersed in the fused

electrolyte. The elements are oxygen-concentration couples, not carbon cells; for the addition of $NaNO_3$ lowers the e.m.f., so that $C^{\cdots}$ ions are not concerned; this addition was recommended by Jacques, whose cell may be an oxidation-reduction couple. The passive metals Fe, Co, Ni, Pt, Au, Ag, Cu, and also constantan and Fe_3O_4 have all the same potential in NaOH; in this respect and as regards the temperature-coefficients and general theory the author agrees with Haber and Bruner, not with Liebenow and Strasser. The kathodically polarised carbon and metals decay quickly. When the fused caustic soda is mixed with Se or Te (1 per cent. and more), the carbon dissolves, but only when anodically polarised; these bodies act as depolarisers, probably under formation of NaSe; H_2Se is not liberated. Sulphur has no depolarising effect, nor have most salts, but $NaNO_3$, $NaClO_3$, $NaClO_4$, $KMnO_4$ have; as regards the $KMnO_4$ the author differs from Haber. The e.m.f. of the cell rises with rising temperature up to 0·9 volt, but sinks rapidly when the electrolyte boils; this takes place in NaOH at 650° or 700° C., in alkali-carbonates at 1100°, in $(B_2O_3 + MgO + CaO)$ at 1350°.
H. B.

1633. *Transport-numbers and Molecular Complexity.* **A. Mazzucchelli.** (Accad. Lincei, Atti, 20. pp. 124–129, Aug. 6, 1911.)—The author shows how the recent work of Einstein and Lorenz on the mobility of ions enables the polymerisation of an electrolyte to be calculated. The transport-number n of an anion is connected with l_a and l_K, the respective mobilities of the anion and kathion by the equation $n = l_a/(l_a + l_K)$, and l also equals $F(/N6\pi\eta\varrho)$; where F is the force acting on a gm.-mol., N the number of molecules in 1 gm.-mol., η the coefficient of internal friction in the liquid, and ϱ is the radius of the molecule (supposed spherical). Further, $\varrho = \sqrt[3]{(3/4\pi . M/SN)}$, and if Q is the equivalent of Ag deposited in the voltameter and q the equivalent of anion transported ($= g/e$, where g is the amount in gm. of anion transported, and e its equivalent), $n = q/Q = g/eQ$, while if a represents the degree of polymerisation and e the minimum equivalent weight $M = ae$. From these equations it is deduced that $F/(N6\pi\eta\sqrt[3]{(3/4\pi . ae/SN)} = l_K g/(Qa\varepsilon - g)$, or putting $F/N6\pi\eta\sqrt[3]{(3/4\pi . e/SN)} = D$, $l_K g = L$, and $Q\varepsilon = G$, then $GDa - Dg = La^{1/3}$, whence a can be determined. Special forms of the equation are developed for particular cases.
W. H. St.

1634. *Calculation of Real Transport-numbers.* **O. Scarpa.** (N. Cimento, 2. Ser. 6. pp. 141–150, Aug., 1911.)—The author deduces from Kohlrausch's theory a general method for calculation of real transport-numbers. Assuming M_mR_n to be an electrolyte furnishing, on complete dissociation, m ions M of valency a and n ions R of valency b, and N_pR_q a second electrolyte having the ion R in common with the first, and giving on complete dissociation p ions N of valency a', and q ions R of valency b, then if U, V, V′ are the limiting mobilities of the ion-equivalents of the two electrolytes, and n_R and n'_R the transport numbers of the ion R in the two electrolytes at the limiting dilution, and λ_∞ and λ'_∞ the respective limiting molecular conductivities, $\lambda_\infty = Kma(U + V) = Knb(U + V)$, and $\lambda'_\infty = Kpa'(U + V') = Kqb(U + V')$, where K is a constant dependent on the units employed; also $n_R = U/(U + V) = KUbn/\lambda_\infty$ and $n'_R = U/(U + V') = KUbq/\lambda'_\infty$, whence $n'_R = n_R(q/n)(\lambda_\infty/\lambda'_\infty)$, from which equation the real transport-numbers of all electrolytes of known limiting molecular conductivities can be calculated. To apply the method to electrolytes not completely dissociated, if a and a' represent the degree of dissociation respectively in the standard, and in the electrolyte under examination and λ and λ' the corresponding molecular conductivities under conditions of equal ionic concentration, then $n'_R = n_R(\alpha'/\alpha)(\lambda/\lambda')$, an equation which enables the real transport-number of the ion R in any binary electrolyte to be calculated for all states of dilution, provided that of the same ion in another electrolyte is known, and that and α and α' are not determined by the electrolytic method. Calculating in this way, and adopting the figures found by Bogdan for KCl, viz., $n_K = 0{\cdot}497$, and $n_a = 0{\cdot}503$, the author has determined the real transport-numbers of H+ in HCl, HNO_3, and H_2SO_4, of Na+ in NaCl, $NaNO_3$, Na_2SO_4, and NaOH, and of K+ in KI, KNO_3, K_2SO_4, $KClO_3$, and KOH, and from the results concludes that the sign of the difference between the real transport-numbers and the Hittorf numbers coincides always with the sense in which the latter varies with increase of dilution.

W. H. St.

1635. *Photography of Electrolytic Metal Deposits.* **B. Wäser** and **R. Kühnel.** (Elektrochem. Zeitschr. 18. pp. 151–156, Sept., 1911.)—The authors study the electrolytic deposits and the electrodes with the aid of the photographic apparatus of A. Martens; the light is admitted from the side and totally reflected in the direction of the longitudinal axis of the apparatus. The experiments concern zinc, lead (after Betts), lead peroxide, &c. So far, a boundary between the kathode and the crystal adhering to it could not be observed.

H. B.

REFERENCES.

1636. *Influence of 0·2 per cent. Vanadium on Steels of varying Carbon-content.* **A. McWilliam** and **E. J. Barnes.** (Iron and Steel Inst., Journ. 83. pp. 294–310; Discussion and Correspondence, pp. 311–317, 1911. Abstracts in Engineering, 91. pp. 652–654, May 19, 1911. Mech. Eng. 27. pp. 768–770, June 23, 1911.)

1637. *Properties of Heat-treated 3 per cent. Nickel Steels.* **A. McWilliam** and **E. J. Barnes.** (Iron and Steel Inst., Journ. 83. pp. 269–289; Correspondence, pp. 290–293, 1911.)

1638. *Some Studies of Welds.* **E. F. Law, W. H. Merrett,** and **W. P. Digby.** (Iron and Steel. Inst., Journ. 83. pp. 103–116; Discussion and Correspondence, pp. 117–124, 1911. Engineering, 91. pp. 617–619, May 12; Discussion, p. 648, May 19, 1911. Mech. Eng. 27. pp. 570–573, May 12, 1911. Abstract.)—The original should be consulted for the photographs of welds made by different methods.

L. H. W.

1639. *Chemical and Mechanical Relations of Iron, Chromium, and Carbon.* **J. O. Arnold** and **A. A. Read.** (Iron and Steel Inst., Journ. 83. pp. 249–260; Discussion and Correspondence, pp. 261–268, 1911. Mech. Eng. 27. pp. 704–707, June 9, 1911.)—The metallographic features are discussed with the aid of the plates given in the original paper. No useful abstract is possible. The mechanical properties of the alloys under static and alternating stress are tabulated.

L. H. W.

1640. *Iron-Silicon-Carbon Alloys.* **W. Gontermann.** (Iron and Steel Inst., Journ. 83. pp. 421–470; Correspondence, pp. 471–475, 1911.)—The subject is treated at great length, the discussion being based upon the experiments made with 12 alloys of different Si-content.

L. H. W.

1641. *On Weak Electrolytes and towards a Dynamical Theory of Solutions.* **W. Sutherland.** (Phil. Mag. 22. pp. 17–66, July, 1911.)